Hydraulic Modeling Report
Clark Fork River Operable Unit—Reach A

Prepared for
Montana Department of Justice
Natural Resource Damage Program
Helena, MT

RDG
RIVER DESIGN GROUP

June 2023

www.riverdesigngroup.com

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Clark Fork River Operable Unit

Reach A

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Acronym	Meaning
BKF	bankfull
BP	base period (used for hydrologic record extension)
cfs	cubic feet per second
CFR	Clark Fork River
CFROU	Clark Fork River Operational Unit
D84	representative sediment size for typical gravel bed rivers
DA	drainage area
DEQ	Montana Department of Environmental Quality
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GIS	Geographic Information System
GPS	Global Positioning System
HEC	Hydrologic Engineering Center
MOVE.1	maintenance of variance type I
NAVD88	North American Vertical Datum of 1988
POR	period of record
Q100	denotes 100-year recurrence interval
RAS	River Analysis System
RMS	root mean square error
sq. mi.	square miles
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WY	Water Year (Oct. 1 – Sept. 30)

1 Introduction

This report presents the results of a hydraulic modeling study undertaken on the Upper Clark Fork River (CFR) in support of remediation and restoration actions in Reach A of the Clark Fork River Operable Unit (CFROU) located within the Milltown Reservoir/Clark Fork River Superfund Site. The Montana Department of Justice Natural Resource Damage Program (NRDP) retained River Design Group, Inc. (RDG) to develop a calibrated reach-scale hydraulic model for use in establishing elevation design criteria in Reach A for tailings removal and floodplain restoration actions. The model will improve the understanding of the water surface elevations and discharges associated with floodplain connectivity and inform the establishment of a functioning riparian corridor. A vicinity map showing the Reach A study area is provided in Figure 1-1.

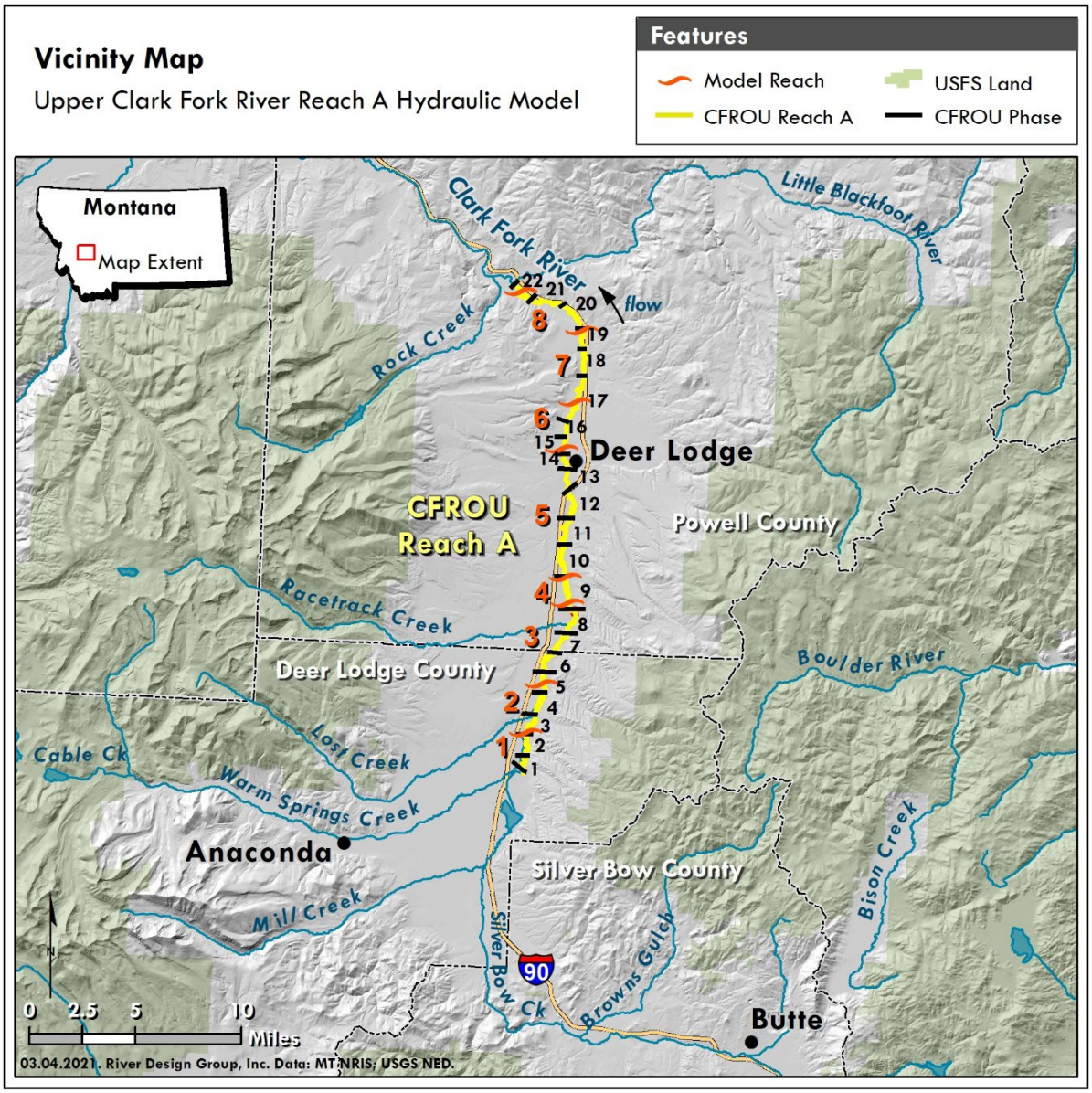

Figure 1-1. CFR Reach A hydraulic model vicinity map.

1.1 Project Background

Heavy metals originating from mining, milling and smelting activities in vicinity of Butte and Anaconda have accumulated in the CFR bed, banks and floodplain for over 100 years. Widespread contamination and damage to natural resources led the U.S. Environmental Protection Agency (EPA) to release a Record of Decision (ROD) for the CFROU in 2004. The ROD, along with several other documents, initiated the process for implementing remedial and restoration actions to address the impacts of heavy metals contamination in the CFROU. Work is being led by the Montana Department of Environmental Quality (DEQ) in collaboration with EPA, NRDP and other project stakeholders.

The CFROU is delineated into three reaches; A, B and C. CFROU Reach A begins downstream of Warm Spring Ponds at the confluence of the CFR and Silver Bow Creek, and extends 47 river miles downstream to the confluence with the Little Blackfoot River at Garrison Junction. Reach A has been further divided into 22 phases for implementation. To date, remediation has been completed in Phase 1 (2014), Phase 2 (2015), Phases 5 and 6 (2016), and Phases 15 and 16 (2020).

Monitoring and observations from completed phases indicate that refinement of design criteria Including floodplain elevations will improve restoration success. Previous design efforts have included hydrologic analysis, hydraulic modeling, vegetation assessments and geomorphic investigations to characterize elevations for floodplain connectivity; however, efforts have been complicated by surface water diversions, un-gaged tributary inputs and differing design approaches employed by the designers. Hence, development of a reach-scale model that addresses data gaps and utilizes a consistent methodology is sought to inform designs for future Reach A phases.

1.2 Previous Studies

Extensive studies have been completed within the Upper CFR watershed including several studies specific to work in Reach A. Information relevant to this modeling effort can be found in the geomorphic investigations, vegetation assessments and engineering analyses completed for CFROU Phase 1 Restoration (CDM, et al. 2010) and CFROU Phase 5 and 6 Restoration (Terragraphics 2016).

1.3 Project Scope

The scope of work for this modeling effort includes survey of geomorphic indicators of bankfull flow, hydrologic analysis of available streamflow data, and development of a calibrated hydraulic model for use in relating the approximate flood frequency and flow duration corresponding to the elevation of surveyed bankfull indicators in CFR Reach A. The scope of work for the hydraulic modeling effort included the following tasks:

- Survey of indicators associated with floodplain connectivity, ecological processes, and sustainable riparian vegetation communities:
- Survey of a continuous profile of near-bankfull flow water surface elevations;

- Measurement of flows at discrete locations during the water surface elevation survey;
- Installation of a network of data loggers to record the range of stage at selected locations;
- Hydrologic analysis including updated flood frequency and flow duration;
- Hydraulic modeling and flood inundation mapping; and
- Reporting and coordination with project stakeholders.

Data collection included cross section surveys, Wolman pebble counts, discharge measurements and a longitudinal profile survey of bankfull indicators. In addition, stage recorders and crest stage gages were installed throughout CFR Reach A. Hydrologic estimates for flood frequency and flow duration were synthesized from available USGS gage sites.

A one-dimensional HEC-RAS hydraulic model was developed and calibrated using the survey data. The hydraulic model was focused primarily on characterizing near-bankfull flows; however, the hydraulic model was also used to map approximate relative inundation depths on the floodplain for larger flows (Q2, Q10, Q25 and Q100). All survey work was performed or directed by a registered professional land surveyor in the State of Montana. All engineering work was performed or directed by a registered Montana professional civil engineer with experience in the analysis of rivers.

1.4 Document Organization

This document is organized into the following sections and appendices.

- ***Section 1 Introduction*** provides project background information and describes the purpose and scope of the study;
- ***Section 2 Data Collection Summary*** summarizes the methods used for field work, data collection, quality control and hydrologic analyses completed to support the hydraulic modeling;
- ***Section 3 Hydraulic Modeling*** summarizes methods and results of hydraulic modeling;
- ***Section 4 Results*** summarizes bankfull discharge analysis results***;***
- ***Section 5 References*** includes citations for literature and studies referenced in the document***;***
- ***Appendix A*** summarizes of the field survey data (survey maps, pebble counts, discharge measurements, stage recorder plots and crest gage readings);
- ***Appendix B*** includes supporting information for the hydrologic analysis;
- ***Appendix C*** includes the hydraulic model schematic, comparisons of surveyed versus modeled water surface elevations and relative inundation depth maps; and,
- ***Appendix D*** includes a table of the bankfull indicator survey data.

2 Data Collection Summary

This section summarizes data collection efforts, quality control and development of CFR Reach A hydrology for use in the hydraulic model. Field surveys were used to characterize existing conditions and establish a baseline of information for use in hydraulic modeling. Hydrologic data for the CFR was developed using analysis of nearby streamflow gage data and regional regression equations. A map illustrating data collection locations is provided in Appendix A.

2.1 Field Data Collection Methods

Field data collection was completed in April, May and June of 2020. A survey-grade GPS system was used to collect topographic data. Horizontal and vertical control benchmarks were also established for future use. Each of the GPS base positions was tied to a minimum of three Continuously Operating Reference Stations (CORS). All survey data were tied to the following horizontal and vertical datums:

Horizontal Datum:	North American Datum of 1983 (2011)
Horizontal Projection:	Montana State Plane (2500)
Horizontal Units:	International Feet
Vertical Datum:	NAVD88 (Geoid 12B)
Vertical Units:	International Feet

Data collection included cross section surveys, pebble counts, discharge measurements, installation of stage gages, and a survey of bankfull indicators. The survey included 257 cross sections and 218 bankfull indicator elevations. Cross sections were surveyed at an average spacing of approximately 1,000 feet. A continuous profile of water surface elevations was surveyed in conjunction with discharge measurements at 15 locations in the study area near the peak of the freshet (June 2 – 5, 2020) for use in model calibration. Continuous river stage monitoring equipment was installed at 15 sites to characterize stage magnitude and duration. Crest-stage gages were installed at 25 sites, 15 of which were paired with the continuous stage recorders to confirm peak river stages. Wolman pebble counts were completed at 25 locations throughout the study area to characterize streambed grain sizes and support hydraulic model roughness estimates. Photographs were also taken at each site at the time of the survey. Discharge measurements, pebble counts, and stage recorder data are provided in Appendix A. The near-bankfull water surface profile is provided in Appendix C. Bankfull indicator data are provided in Appendix D.

2.2 Data Inspection and Quality Control

Quality control measures were employed to inspect field data and identify potential issues that could influence hydraulic modeling outcomes. The following potential issues were identified and investigated:

- Discharge discrepancies between USGS gage data and field discharge measurements;

- Decreasing discharge in the downstream direction;
- Elevation differences between stage recorder readings and synoptic water surface measurements;
- Elevation differences between LiDAR data and field surveyed cross sections; and
- Partial transects for Wolman pebble counts.

Discrepancies were found between USGS gage data and field discharge measurements. In general, field measurements were found to be less than reported USGS gage data. Significant discrepancies were observed at the USGS CFR Deer Lodge gage and USGS CFR Garrison gage, where multiple field measurements taken upstream and downstream of the gages were approximately 150 to 300 cfs less than the discharge reported at the gage during high flow (Appendix A, Table A-2). The reason for the discrepancy is unclear but could be related to unsteady flow conditions, measurement cross section irregularities (i.e., non-uniform flow), measurement error, or provisional USGS data. Nonetheless, these high flow measurements (TBM8-TBM12) were regarded as outliers and not used in the analysis. Low flow measurements at 9 of the 25 sites were also questioned and not used in the analysis (TBM 7, TBM9, TMB16, TBM 20-25).

Decreasing discharge in the downstream direction was observed at a few locations during the June high flow measurements (Appendix A, Table A-3). One such site is the Alvi-Beck diversion in CFROU Phase 5. Other such surface water diversion sites were found upstream of Deer Lodge. Results indicate that surface water diversions may have a significant effect on discharge magnitude and associated water surface elevations. Conversely, irrigation returns and narrowing of the valley at the downstream end of Reach A may be adding flow to the reach at other locations. Additional information is needed to quantify surface water diversions, irrigation returns and subsequent effects on hydrology. No adjustments for diversions or returns were made in the model at this time.

Comparisons between stage recorder readings and synoptic water surface measurements were generally found to be good and within the GPS measurement error. Minor discrepancies could be related to longitudinal distance between the stage recorder and measurement location (water surface slope) as well as sedimentation in the stage recorder pipe casings. The stage recorder casing at TBM7 was damaged during high flow and measurements were discontinued. Stage recorder plots show a continuous stage record during late summer months; however, site inspections found the bottom of the pipes out of the water. As such, stage recorder data during the low flow period may be suspect.

Elevation differences between LiDAR data and surveyed cross sections were found to be minor and within accepted vertical accuracy tolerances. Survey data were used for the bankfull channel cross section geometry and LiDAR data were used for floodplain geometry beyond the banklines.

Channel depth and velocity limited Wolman pebble count data collection at the downstream end of Reach A. Measurement transects did not capture the deepest part of the channel, and

therefore actual grain size distributions may be larger than reported. Sensitivity analyses completed for relative roughness calculations found low correlation between estimated roughness and larger grain sizes. As such, no corrections were made to grain size distributions and no pebble count data were omitted.

2.3 Hydrologic Analyis

The headwaters of the CFR originate in Silver Bow Creek and Anaconda Creek. A portion of Silver Bow Creek is routed through Warm Springs Ponds just upstream of its confluence with Warm Springs Creek. There are 21 tributaries that join the CFR through Reach A (Figure 2-1). Major tributaries (with contributing area greater than 10 square miles) that flow from the west out of the foothills of the Flint Creek Range include Warm Springs Creek, Lost Creek, Racetrack Creek, Dempsey Creek, Modesty Creek, Tin Cup Joe Creek, Powell Creek and Taylor Creek. Major tributaries that flow from the east out of the eroded hills of the Boulder Batholith include Cottonwood Creek, Peterson Creek, O'Neill Creek, Dry Cottonwood Creek and Orofino Creek. A summary of CFR Reach A tributaries and contributing drainages areas is provided in Table 2-1.

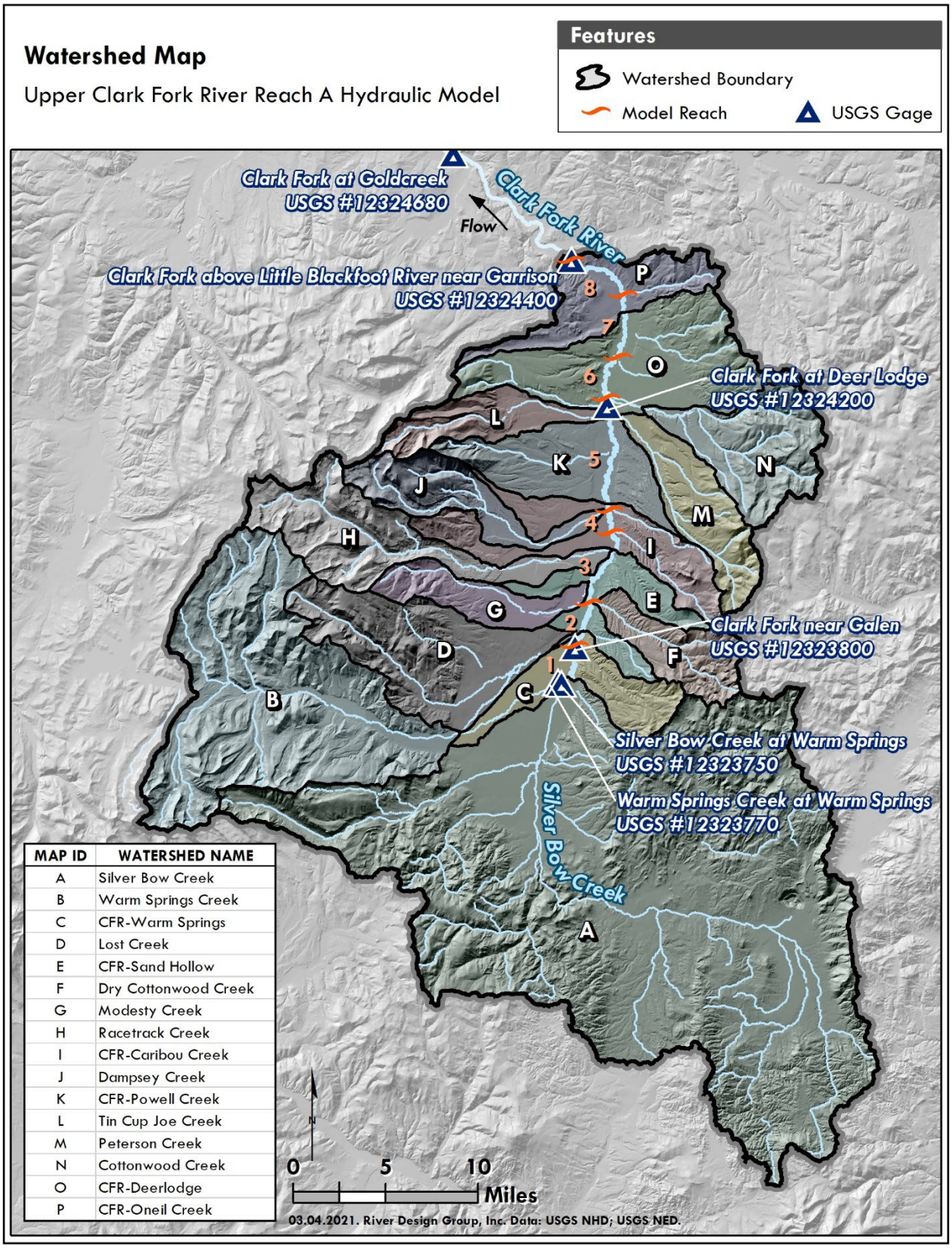

Figure 2-1. CFR Reach A watershed and tributary map.

Four USGS streamflow gages are located in Reach A. The upstream most gage is located on Silver Bow Creek (USGS # 12323750) which is the major tributary to the upper CFR. The CFR near Galen gage (USGS # 12323800) is approximately 2 miles upstream of the Galen Road bridge. The CFR at Deer Lodge gage (USGS # 12324200) is located in Deer Lodge. The CFR above Little Blackfoot River gage (USGS # 12324400) is located near Garrison Junction. An additional gage used in the analysis is located downstream of the Blackfoot River junction near Gold Creek (USGS # 12324680).

Table 2-1. CFR Reach A major tributaries and contributing drainage areas.

CFR Analysis Point	Tributary Drainage Area (sq. mi.)	Hillslope Area (sq. mi.)	Total Drainage Area (sq. mi.)	Δ Drainage Area (sq. mi.)	Percent Increase
Warm Springs Ponds	476	-	476	-	-
Warm Springs Creek-Perkins Gulch	164.4	6.7	656	180.3	37.9%
Sand Creek	4.7	3.0	664	7.6	1.2%
Lost Creek	61.5	0.0	725	61.5	9.3%
Dry Cottonwood Creek	23.4	2.8	751	26.2	3.6%
Modesty Creek	24.9	0.7	777	25.6	3.4%
Sand Hollow	8.3	2.4	788	10.7	1.4%
Racetrack Creek	51.6	0.1	839	51.6	6.6%
Orofino Creek	10.5	12.3	862	22.8	2.7%
Caribou-Dempsey Creek	35.0	2.2	899	37.2	4.3%
Powell Creek	16.3	23.1	939	39.4	4.4%
Peterson Creek	31.1	7.8	978	39.0	4.2%
Tin Cup Joe Creek	23.0	0.3	1,001	23.3	2.4%
Taylor Creek	10.0	0.1	1,011	10.1	1.0%
Cottonwood Creek	44.2	0.2	1,055	44.4	4.4%
Spring Gulch	7.9	6.4	1,070	14.3	1.4%
Fred Burr Creek	2.6	0.3	1,073	2.8	0.3%
Mullan Gulch	10.0	6.2	1,089	16.2	1.5%
ONeill Creek	30.3	2.0	1,121	32.4	3.0%
Little Blackfoot River	415.0	22.4	1,559	437.5	39.0%

Peak flow estimates for this study were computed using methods recommended by Sando et al. (2018b). The period of record used for each gage in the hydrologic analysis is summarized in Table 2-2. Peak flows for recurrence intervals from 1 year to 1.49 years were computed by RDG. Peak flows for recurrence intervals from 1.5 years to 500 years were computed by USGS (2018b). Flows for each analysis point interpolated using the logarithm of peak flows method recommended by Sando et. al. (2018a) are provided in Table B-1 (Appendix B). These flows were used in the estimation of recurrence interval for the bankfull indicator analysis. Bankfull flows listed in Table

B-1 were computed as 84% of the 2-year flood discharge after Lawlor (2004) and are provided for reference only.

Peak flow estimates developed for this report were compared with recent estimates published by others. Flood frequency statistics were published by USGS in 2016 using Bulletin 17b methods (Sando et al. 2016) and in 2018 Bulletin 17c methods (Sando et al. 2018b). For the 2018 study, Sando et al. also extended the period of record for the gages in the study area using the MOVE.1 maintenance of variance method (Sando et al. 2018b). A Flood Insurance Study (FIS) of the CFR in Deer Lodge County was completed for the Federal Flood Insurance Program in 1994 (FEMA). Peak flows from these studies are compared in Table 2-2.

The FEMA FIS flood quantiles were developed using regression equations available at that time and are comparable to quantiles determined using the current West Region regression equations. At the time of the FEMA FIS study, the Deer Lodge gage (USGS # 12324200) had just started operation and the Galen gage (USGS # 12323800) had not yet been established. These two gages provide site specific data that is more accurate than estimates from previous or current regression equations for this area. Therefore, we conclude that the gage analysis completed for this study is a better representation of the current Upper CFR hydrology, with the possible exception of the 100-year flood flow as described below.

Peak flood flows for the 100-year event on Silver Bow Creek upstream of Warm Springs Ponds are generally accepted to be 3,300 cfs and are referenced as such in the Warm Springs Ponds Record of Decision (Terragraphics 2012). To prevent potential failure of the ponds, 100-year recurrence or larger events are bypassed around the ponds through a sand-plug levee. A flow much larger than the 100-year peak flow reported in the Phase 1 Study (CDM and AGI 2010) could be released to the CFR (Terragraphics 2012). Only two of the three ponds are currently in use, but their combined area of 2,400 acres results in significant modification of flows on Silver Bow Creek. Although they are not operated for flood storage purposes, their large surface area allows sufficient short-term detention to reduce flood peaks (CDM 2010). If water quality improves to the point that the ponds are no longer needed, Silver Bow Creek could be diverted around the ponds in which case the flood hydrology of the Upper CFR would change, and larger peak flows could occur along with greater sediment delivery to the system.

Peak discharge estimates are often correlated with geomorphic indicators such as channel forming discharge, channel maintenance discharge or the threshold of floodplain activation; however, because they are developed by fitting a Log Pearson Type III extreme event probability distribution to instantaneous peaks, they are more appropriate for ascertaining flood risk, and do not necessarily correlate well with hydraulic geometry below the 10-year recurrence interval.

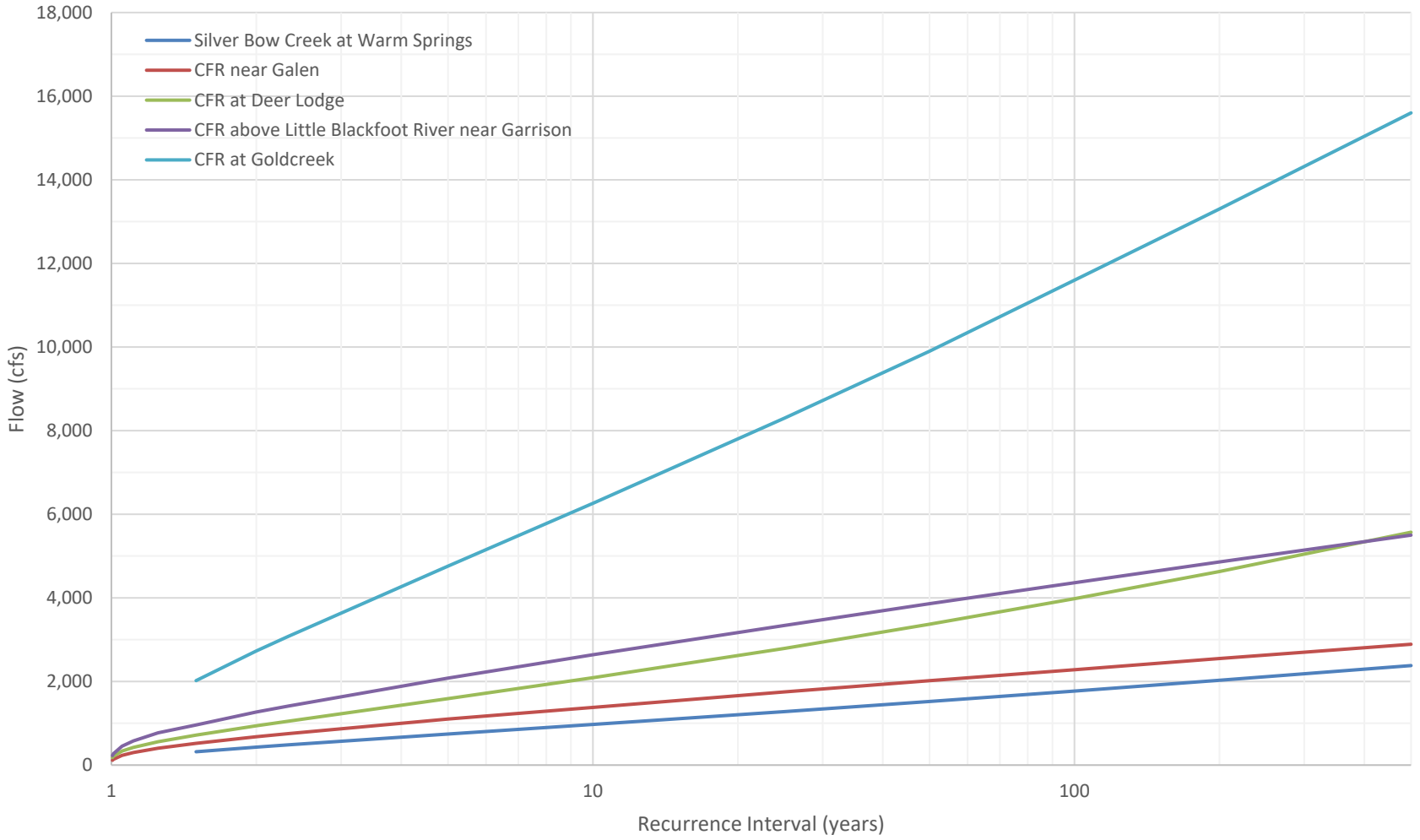

Figure 2-2. Flood discharge curves for Silver Bow Creek and CFR gages used for analysis of bankfull indicator recurrence interval.

Table 2-2. Comparison of CFR Reach A peak flow estimates at gages (cfs).

Gage	Source[a]	Analysis Period of Record (n peak flows)	Recurrence Interval (years)								
			Bkf[b]	1.5	2	5	10	25	50	100	500
CFR nr. Galen	Phase 5-6 Design Rpt.	1989–2011 (22)	n/a	n/a	636	936	1,134	1,379	1,558	1,733	n/a
USGS #12323800	USGS 17b	1989–2011 (22)	492	n/a	586	971	1,230	1,550	1,790	2,010	2,510
	USGS 17c	1989–2018 (30)	498	454	593	947	1,180	1,460	1,660	1,860	2,280
	USGS 17c Ext.	**BP 1899–1908, 1930–2018 (99)**	***569***	***519***	***677***	***1,100***	***1,380***	***1,750***	***2,020***	***2,280***	***2,890***
	Phase 5-6 Design Rpt.	1979–2011 (32)	n/a	n/a	893	1,502	1,946	2,542	3,006	3,484	n/a
CFR at	FEMA FIS	n/a	n/a	n/a	n/a	n/a	6,340	n/a	8,470	9,410	n/a
Deer Lodge	USGS 17b	1979–2011 (32)	751	n/a	894	1,500	1,950	2,540	3,010	3,480	4,650
USGS #12324200	USGS 17c	1979–2018 (40)	752	681	895	1,500	1,950	2,550	3,030	3,520	4,750
	USGS 17c Ext.	**BP 1899–1908, 1930–2018 (99)**	***790***	***717***	***940***	***1,590***	***2,090***	***2,790***	***3,370***	***3,980***	***5,570***
CFR above Little Blackfoot R. nr. Garrison	USGS 17c	2009–2018 (10)	1,067	972	1,270	2,100	2,710	3,530	4,180	4,840	6,490
USGS #12324400	***USGS 17c Ext.***	**BP 1938–2018 (81)**	***1,067***	***958***	***1,270***	***2,080***	***2,640***	***3,340***	***3,860***	***4,360***	***5,500***
CFR at Goldcreek	USGS 17c	1978–2011 (34)	1,999	1,800	2,380	4,170	5,640	7,840	9,740	11,900	17,800
USGS #12324680	***USGS 17c Ext.***	**BP 1899–1908, 1930–2018 (99)**	***2,293***	***2,020***	***2,730***	***4,760***	***6,260***	***8,300***	***9,900***	***11,600***	***15,600***

[a] Log-pearson Type III peak flow analysis using Bulletin 17b/17c methods (Sando et al. 2016, Sando et al. 2018b).

[b] Bankfull estimated using 0.84 * Q2 (Lawlor 2004).

Flow duration statistics are often used in the design of fish passage facilities. The 80% exceedance flow is often used as the minimum fish passage design flow and the 10% exceedance flow is often used as the maximum fish passage design flow. Flow duration estimates were developed for the full year (annual duration) and typical irrigation season of May 1 through September 30 (irrigation season duration) using daily flow data from USGS gages. Flow duration curves for the 9-year period common to all gages (WY 2010 – WY 2018) were compared with the flow duration curves for the entire period of record for each gage. Using the common 9-year period produced curves that generally overestimate flows as can be seen in Figure 2-3. Flow duration was computed using the full period of record for each gage. Flow duration statistics for each gage are presented in Table 2-3.

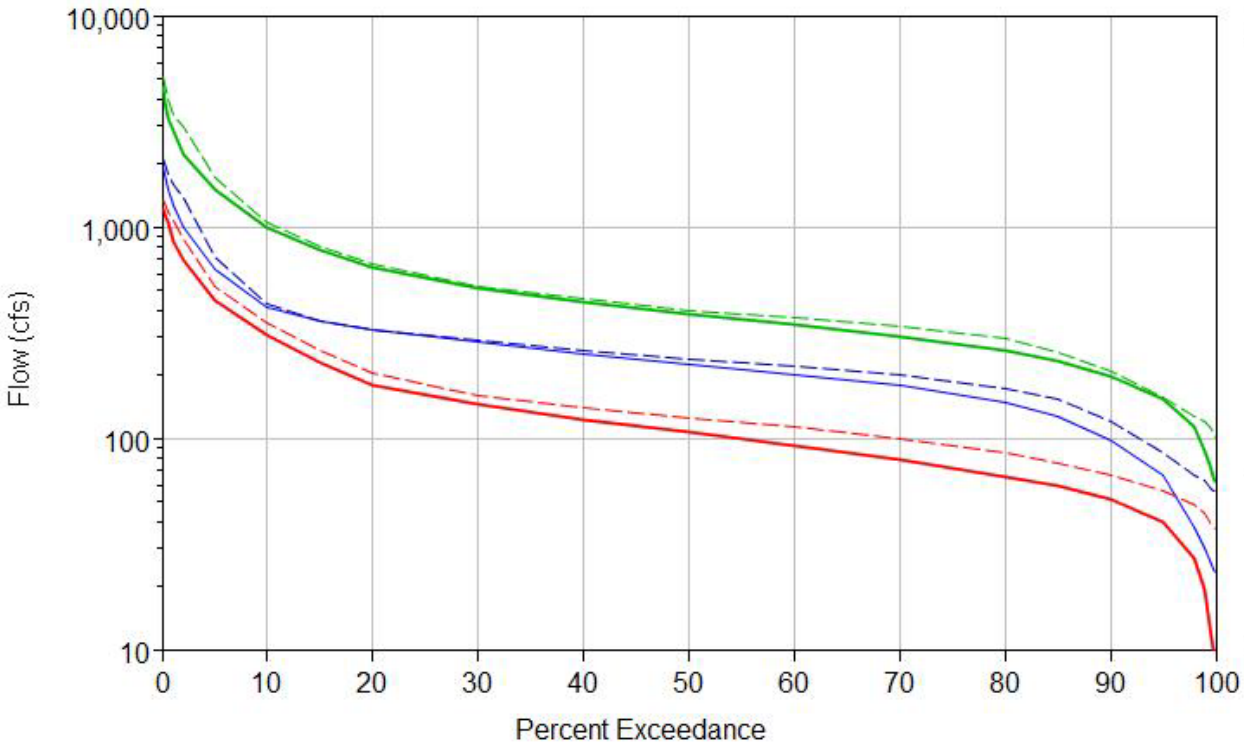

Figure 2-3. Annual flow duration curves for selected CFR gages showing difference between full period of record and 9-year period common to all gages. Dashed lines are for the 9-year common POR and solid lines for the full POR. Green lines are CFR at Gold Creek, blue lines are CFR at Deer Lodge, and red lines are CFR at Galen.

Table 2-3. CFR Reach A annual flow duration statistics.

Percent Of Time Exceeded	USGS Gage and Drainage Area (square miles)				
	Silver Bow Creek at Warm Springs	CFR near Galen	CFR at Deer Lodge	CFR above Little Blackfoot River near Garrison	CFR at Gold Creek
	473	**656**	**1001**	**1130**	**1774**
0.1	916	1,223	1,917	2,358	4,663
0.2	772	1,160	1,783	2,320	3,947
0.5	680	1,050	1,500	2,010	3,270
1	588	851	1,260	1,779	2,830
2	472	687	988	1,540	2,180
5	311	452	630	1,030	1,500
10	217	305	419	635	989
15	170	225	358	454	770
20	139	179	327	385	647
30	105	144	286	333	514
40	82	122	252	300	441
50	70	106	224	275	388
60	62	91	200	253	343
70	53	79	177	230	304
80	44	66	148	196	260
85	39	59	127	170	230
90	34	51	98	137	196
95	28	40	66	100	152
98	23	27	38	72	112
99	21	19	30	68	87

3 Hydraulic Modeling

The hydraulic model of CFR Reach A was developed using HEC-RAS v5.0.7 (USACE 2019). The model is a one-dimensional gradually varied steady flow model of the 47-mile reach. The model begins in Warm Springs and extends downstream of the confluence with the Little Blackfoot River. The model schematic is included in Appendix C.

3.1 Topographic Data

Geometric data for the existing channel and floodplain were sampled from the cross-section points surveyed in April 2020 merged with 2019 Lidar (Quantum 2020). Cross sections were sampled using the HEC-GeoRAS utility within ArcGIS.

3.2 Model Geometry

A total of 257 cross sections were used to represent the geometry of the existing channel and floodplain. The cross sections were oriented to remain perpendicular to the expected flow lines for both small (1- to 50-year) and large magnitude (100- to 500-year) flood events, sometimes requiring multiple horizontal inflection points. The cross sections extend orthogonally across the floodplain to capture the maximum potential inundation for the estimated 500-year flood elevations.

3.3 Boundary Conditions

The downstream boundary for the model was approximated using a normal depth slope of 0.002 ft/ft. The downstream boundary was selected approximately one mile downstream of the Reach A terminus to avoid the potential for influencing study results.

3.4 Roughness Parametrization

Roughness coefficients were parameterized based on bed material grain size. Relative roughness was used to estimate Manning's roughness coefficients for the main channel under near-Bankfull discharge conditions using a D_{84} value of 63 mm (Rosgen 1998). Roughness was parameterized for near-bankfull flows using 577 cfs for Model Reaches 1 through 6 (HEC-RAS River Stations greater than 60,074) and 955 cfs for Model Reaches 7 and 8 (HEC-RAS River Stations less than 60,074). Manning's roughness values for the for the main channel bankfull model geometry range from 0.028 to 0.037 with an average of 0.031. Roughness values were then re-computed for the 100-year event. Main-channel Manning's n values for the 100-year event ranged from 0.026 to 0.030 with an average of 0.027. Floodplain roughness values were set at 0.070 for both models. A single floodplain roughness value was used given the focus on bankfull discharge and no variations to floodplain roughness were made based on floodplain characteristics. Selected roughness values are within the range of values for natural streams reported in Arcement and Schneider (1989).

3.5 Model Validation

A continuous profile of water surface elevations was surveyed in CFR Reach A during a period of near-bankfull flows in June 2020. During the same survey, near-bankfull discharge was measured at 15 locations (Sites TBM1 through TBM15) corresponding to stage recorder sites, pebble count measurements and crest stage gages. The surveyed elevations were used to validate the water surface elevations predicted by the model. Validation points were selected near the surveyed cross sections. The longitudinal distance from the surveyed validation points to the cross sections ranged from 0.2 feet to 44 feet with a median distance of 5 feet. Modeled water surface elevations were interpolated between cross sections to the location of the surveyed validation point. Discharge measurements are summarized in Appendix A. Comparisons between surveyed and modeled water surface elevations at near-bankfull discharge are provided in Appendix C.

The difference in elevation between surveyed and modeled water surface elevations ranged from -1.15 feet to +0.99 feet with a median difference of +0.01 feet, average difference of -0.05 feet, and root mean square difference of 0.34 feet. A histogram showing the distribution of differences is shown in Figure 3-1. The difference in elevation was examined to determine if there was a correlation of location within reach or distance of surveyed point from model cross section. No correlation with either factor was evident as can be seen in Figure 3-2 and Figure 3-3. Based on these results, the model appears to be well parameterized for near-bankfull flows and suitable for use in this analysis.

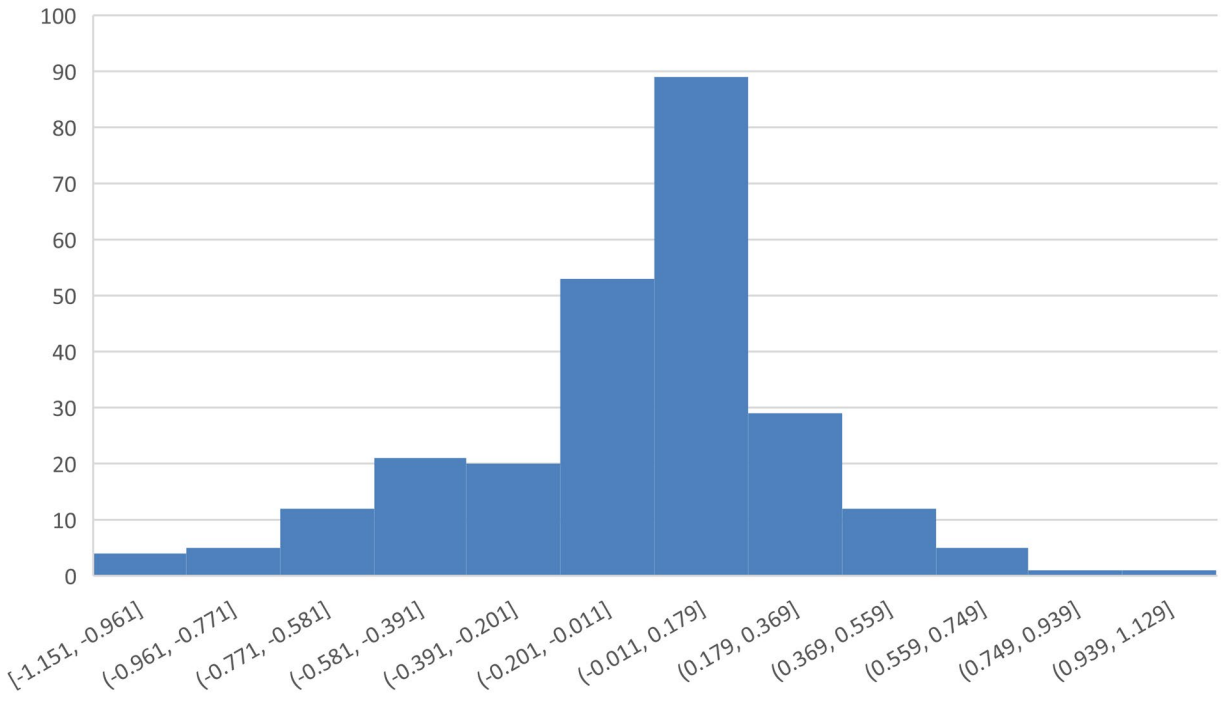

Figure 3-1. Histogram showing the distribution of differences between surveyed and modeled water surface elevations at near-bankfull flows.

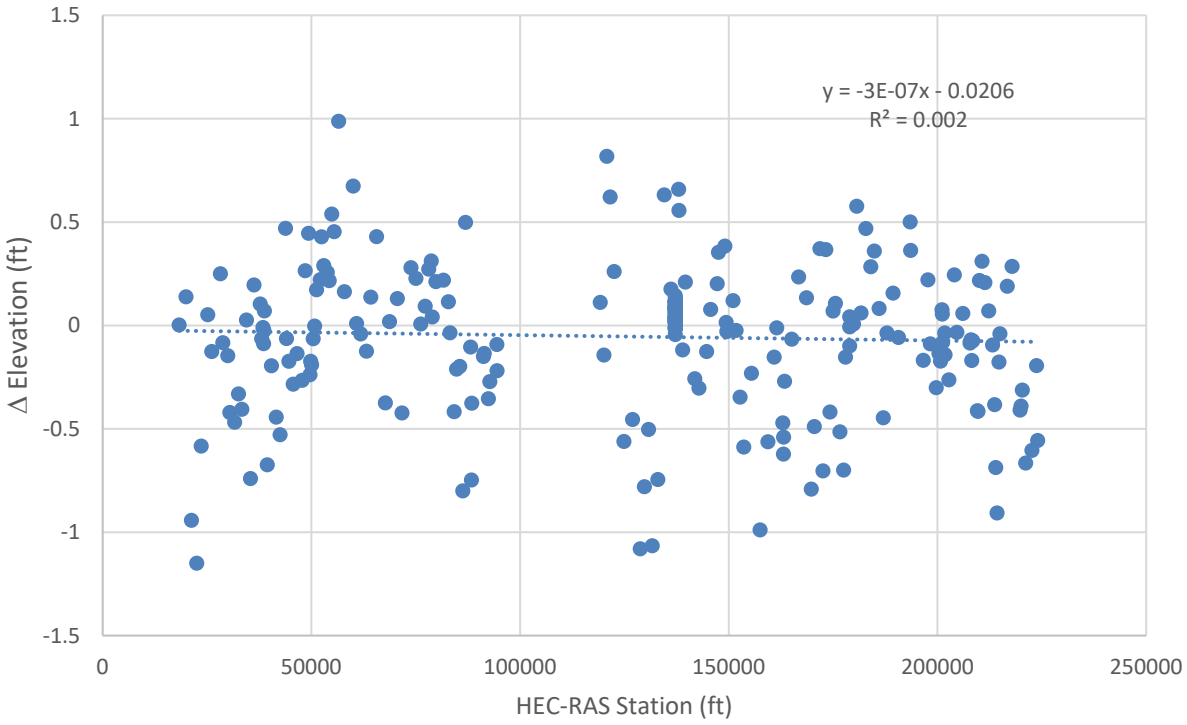

Figure 3-2. Plot showing the distribution of differences between surveyed and modeled water surface elevation by station.

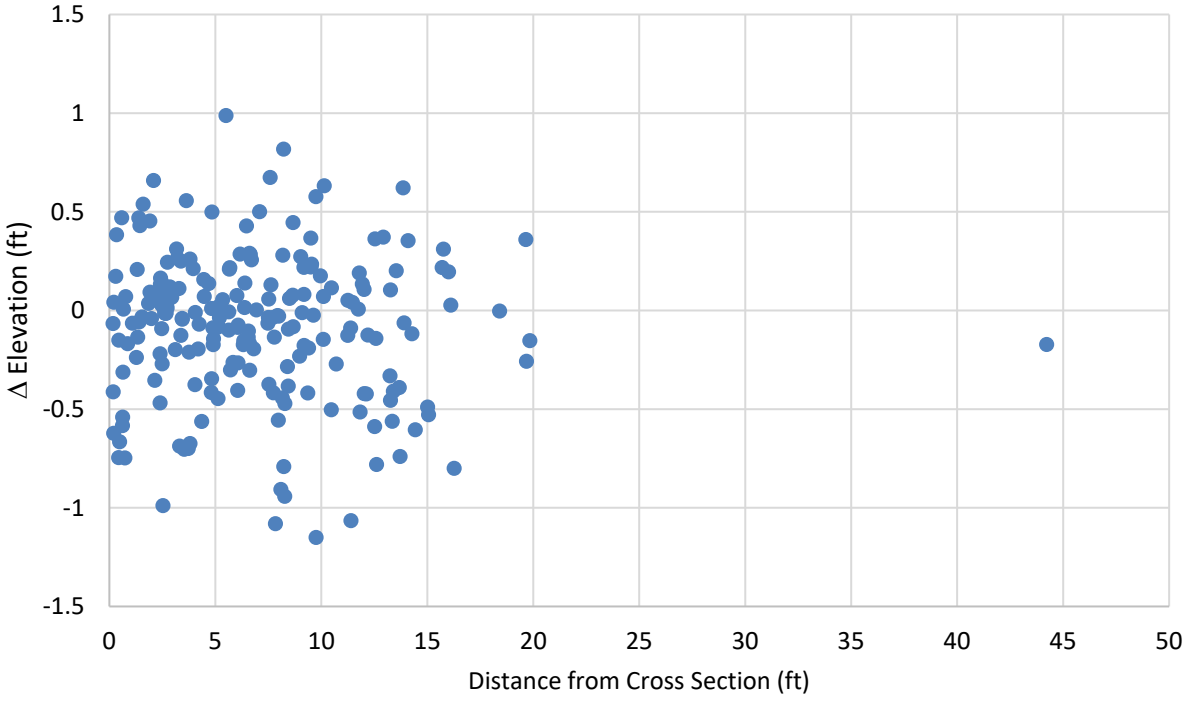

Figure 3-3. Plot showing the distribution of differences between surveyed and modeled water surface elevation by distance from cross section.

3.6 Sensitivity Analysis

Following the bankfull flow analysis, Manning's roughness values were adjusted for the median bankfull flow for each model reach using the Rosgen equation for relative roughness (Rosgen 1998). Changes in roughness values relative to the calibration run ranged from -0.004 to 0.000 with an average of -0.001. This resulted in changes in water surface elevations of -0.16 feet to +0.01 feet with an average of -0.05 feet. This small change in water surface elevation suggests that the initial model was well-calibrated and suitable for use in the bankfull analysis.

The sensitivity of the model to the downstream boundary condition was examined by decreasing the slope used in the normal depth approximation by an order of magnitude to 0.0002 ft/ft. The results show that changes to the slope assumed for the downstream boundary impact the water surface elevations upstream a distance of about one mile which is downstream of the area of interest in the bankfull analysis.

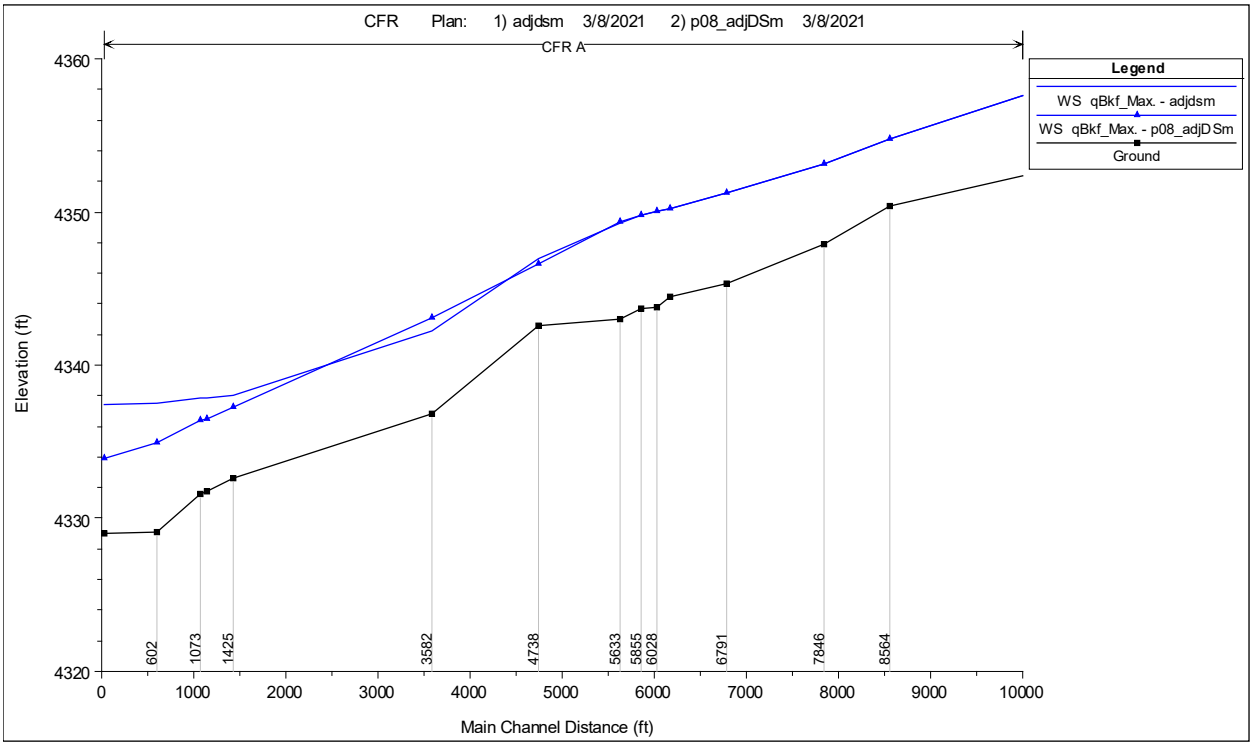

Figure 3-4. Plot showing sensitivity of model to downstream boundary condition.

3.7 Model Limitations

The CFR Reach A model is a reach-scale model that was developed primarily as a tool to aid in the determination of bankfull flow. Cross sections represent selected features associated with geomorphic indicators of bankfull flow. There may be deviations between the reported water surface elevations and actual water surface elevations between cross sections due to features (e.g., riffles and pools) located in the area between cross sections that are not represented in the

model geometry. For design-scale modeling, additional cross sections may be required to reflect localized changes in water surface elevations.

Additional model limitations include simplification of floodplain roughness and exclusion of hydraulic structures. Floodplain roughness was treated as a uniform value as overbank flows were of secondary importance to this effort. In addition, hydraulic structures such as bridges were omitted from the model. These structures are assumed to have minimal influence on water surface elevations for flows less than bankfull stage. More detailed parameterization of floodplain roughness and inclusion of hydraulic structures may be warranted to ensure adequate model performance for flows above bankfull stage.

4 Results and Conclusions

4.1 Selection of Model Reaches for Bankfull Discharge Analysis

The CFR Reach A model was divided into eight model reaches representing locations of tributary inputs with significant drainage areas that could contribute to bankfull discharge. Efforts were made to select model reaches with sufficient surveyed bankfull points to provide a reasonable sample size for computing bankfull discharge and recurrence interval statistics for each model reach. Table 4-1 summarizes the CFR Reach A model reaches, cumulative drainage area and number of bankfull indicators by reach.

Table 4-1. Bankfull Analysis Reaches.

Model Reach	CFROU Phases	Downstream HEC-RAS Station (ft)	Contributing Tributaries	Drainage Area (sq. mi.)	Number of Bankfull Indicators
1	(1, 2)	223,760	Perkins Gulch, Warm Springs Creek, Sand Creek	664	17
2	(3, 4)	196,630	Lost Creek, Dry Cottonwood Creek, Modesty Creek	777	30
3	(5 – 8)	152,744	Sand Hollow, Racetrack Creek, Orofino Creek, Dempsey Creek	899	37
4	(9)	141,293	Caribou Creek, Powell Creek	939	27
5	(10 – 14)	85,581	Peterson Creek, Tin Cup Joe Creek, Taylor Creek, Cottonwood Creek, Spring Gulch	1,070	23
6	(15, 16)	63,252	Fred Burr Creek, Mullan Gulch	1,089	28
7	(17 – 19)	37,773	O'Neill Creek	1,121	33
8	(20 – 22)	6,791	Little Blackfoot River	1,559	6

4.2 Bankfull Discharge Estimates

Bankfull discharge was estimated for each model reach by comparing the elevation of 201 of the 218 geomorphic indicators surveyed in the field with hydraulic model results. Nine indicators with recurrence intervals greater than 5 years were deemed outliers and eight others were not included in the analysis for various reasons. The flows associated with the selected bankfull indicators ranged from a minimum of 279 cfs in the upstream most reach to a maximum of 1,786 cfs in the downstream most reach (Figure 4-1). Recurrence intervals associated with bankfull discharge range from 1.01 years to 4.14 years with a median of 1.78 years, and an average of 2.26 years. Results of the analysis are presented by model reach in Figure 4-2 and Table 4-2. Table 4-3 provides a summary of the difference in stage that occurs between the maximum and minimum recurrence interval in each model reach. Table 4-4 provides a summary of the difference in stage that occurs between the median and minimum recurrence interval in each reach.

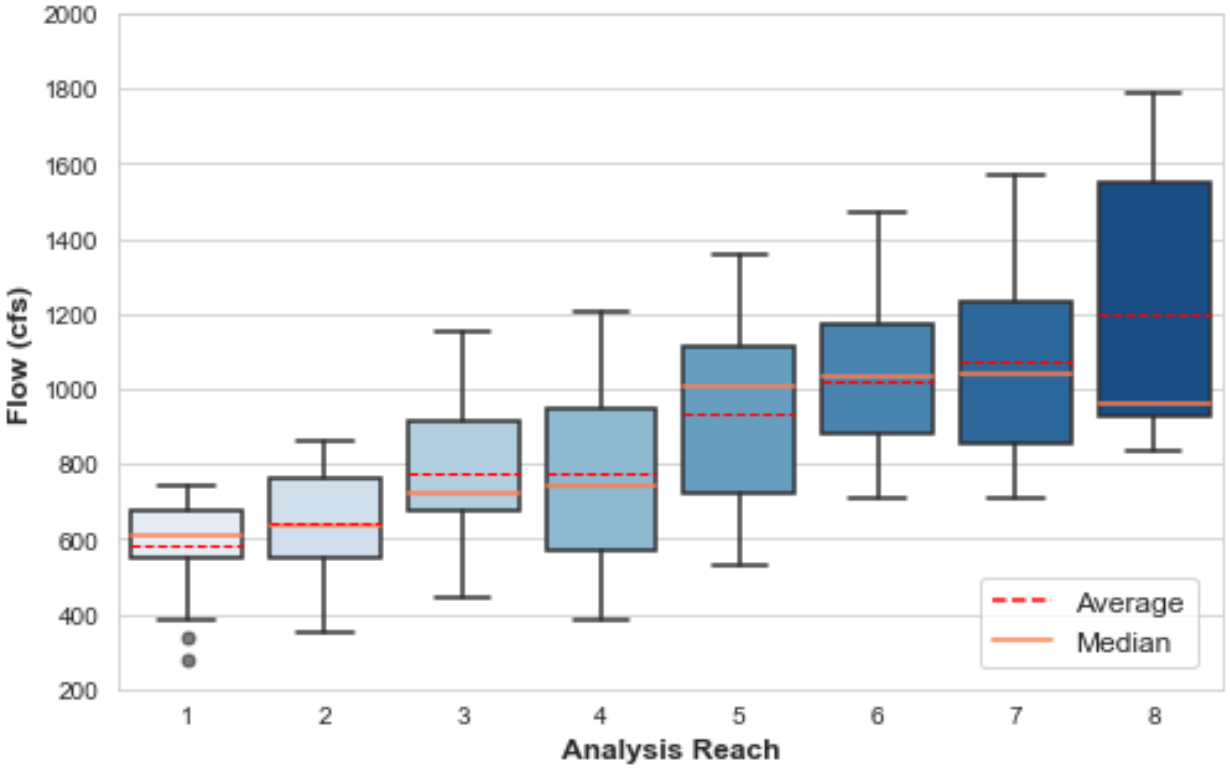

Figure 4-1. Range of bankfull indicator flows by model reach.

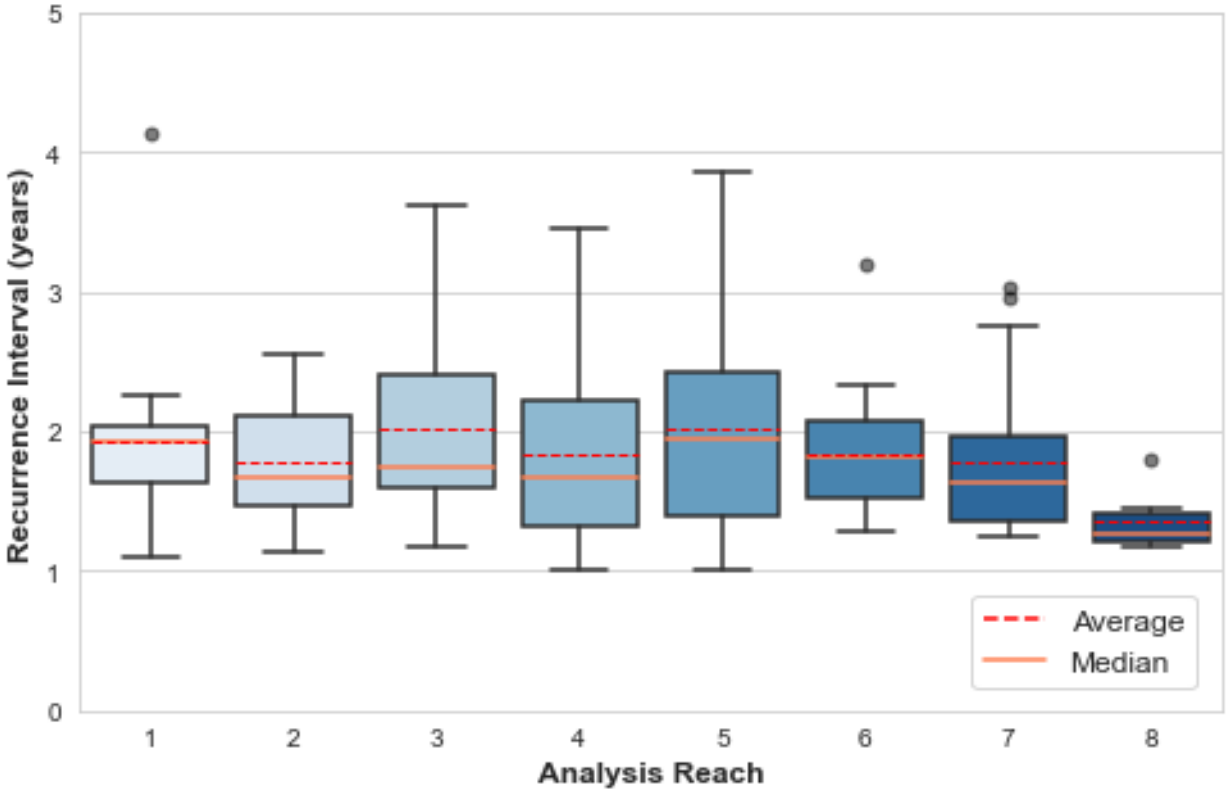

Figure 4-2. Range of bankfull indicator recurrence interval by model reach.

Table 4-2. Summary of CFR Reach A estimated bankfull discharge and recurrence interval by model reach and CFROU phase.

Model Reach	CFROU Phases	Bankfull Discharge (cfs)				Recurrence Interval (years)			
		Min.	Median	Average	Max.	Min.	Median	Average	Max.
1	(1, 2)	279	612	583	742	1.10	1.93	1.93	4.14
2	(3, 4)	353	633	643	861	1.14	1.68	1.78	2.56
3	(5 – 8)	441	721	774	1,150	1.18	1.74	2.03	3.62
4	(9)	386	742	773	1,206	1.01	1.66	1.84	3.45
5	(10 – 14)	533	1,004	935	1,359	1.01	1.95	2.02	3.85
6	(15, 16)	708	1,034	1,018	1,468	1.29	1.81	1.83	3.19
7	(17 – 19)	712	1,042	1,070	1,567	1.25	1.64	1.78	3.02
8	(20 – 22)	836	960	1,201	1,786	1.17	1.27	1.36	1.80

Table 4-3. Difference in flow and WSEL for range of estimated recurrence intervals for bankfull discharge.[1]

Model Reach	CFROU Phases	Minimum RI (years)	Maximum RI (years)	Δ Flow (cfs)	Minimum Δ Stage (feet)	Average Δ Stage (feet)	Maximum Δ Stage (feet)
1	(1, 2)	1.10	4.14	463	1.20	1.61	1.85
2	(3, 4)	1.14	2.56	508	1.20	1.41	2.03
3	(5 – 8)	1.18	3.62	710	0.79	1.58	2.02
4	(9)	1.01	3.45	820	1.06	1.58	2.15
5	(10 – 14)	1.01	3.85	826	1.19	1.54	1.99
6	(15, 16)	1.29	3.19	761	1.01	1.38	1.66
7	(17 – 19)	1.25	3.02	856	1.13	1.50	1.89
8	(20 – 22)	1.17	1.80	950	1.42	1.62	1.76

[1] Statistics based on modeled values for recurrence intervals at each cross section within the model reach.

Table 4-4. Difference in flow and WSEL between estimated minimum and median recurrence intervals for bankfull discharge.[1]

Model Reach	CFROU Phases	Minimum RI (years)	Median RI (years)	Δ Flow (cfs)	Minimum Δ Stage (feet)	Average Δ Stage (feet)	Maximum Δ Stage (feet)
1	(1, 2)	1.10	1.93	333	0.91	1.22	1.42
2	(3, 4)	1.14	1.68	280	0.77	0.88	1.27
3	(5 – 8)	1.18	1.74	280	0.43	0.80	1.03
4	(9)	1.01	1.66	357	0.53	0.85	1.16
5	(10 – 14)	1.01	1.95	471	0.73	0.99	1.24
6	(15, 16)	1.29	1.81	326	0.46	0.69	0.85
7	(17 – 19)	1.25	1.64	330	0.52	0.73	0.99
8	(20 – 22)	1.17	1.27	124	0.22	0.27	0.29

[1] Statistics based on modeled values for recurrence intervals at each cross section within the model reach.

4.3 Bankfull Discharge Uncertainty

An error budget analysis was completed to provide an approximation of the accuracy of the discharge estimates. The primary sources of error likely to affect the analysis results are limitations on the accuracy of GPS surveyed bankfull indicator elevations and uncertainty in modeled water surface elevations. The GPS surveys are capable of resolving vertical accuracy within approximately +/- 0.2 feet. The RMS error for the hydraulic model calibrated for near-bankfull flows was 0.34 feet. This suggests a combined accuracy of approximately +/- 0.5 feet for the bankfull indicators. Testing of the 100,000,000-node computational grid used to interpolate bankfull flow showed an average difference of 0.03 cfs (range -8.4 to +4.8 cfs) relative to the next coarser grid spacing of 50,000,000 nodes. This level of computation error is insignificant relative to the range of differences in bankfull flow reported in Tables 4-3 and 4-4.

4.4 Flow Duration Estimates

Flow duration was estimated for each model reach by comparing elevations of the 201 geomorphic indicators described in Section 4.2 with hydraulic model results. Flow duration associated with bankfull discharge ranged from 4.8 days to 42.5 days (1.3% to 11.6%) with a median of 15.3 days (4.2%), and an average of 16.6 days (4.6%). Results of the analysis are presented by model reach in Table 4-5 and Figure 4-3**.**

Table 4-5. Summary of CFR Reach A flow duration statistics for surveyed bankfull indicators (percent of time exceeded and number of days exceeded per year) by model reach and CFROU phase.

Model	CFROU	Flow Duration (percent of time exceeded)				Flow Duration (number of days exceeded)			
Reach	Phases	Min.	Median	Average	Max.	Min.	Median	Average	Max.
1	(1, 2)	1.4%	4.0%	4.5%	11.6%	5.2	14.7	16.5	42.5
2	(3, 4)	3.2%	4.4%	4.6%	9.7%	11.5	16.0	16.6	35.5
3	(5 – 8)	1.9%	4.1%	3.9%	8.7%	6.9	14.9	14.3	31.8
4	(9)	1.5%	3.9%	4.2%	11.1%	5.4	14.2	15.3	40.6
5	(10 – 14)	1.3%	3.3%	4.0%	8.8%	4.8	12.0	14.6	32.1
6	(15, 16)	1.9%	4.3%	4.9%	8.5%	7.1	15.6	17.9	30.8
7	(17 – 19)	3.0%	6.0%	6.2%	10.3%	11.0	22.1	22.8	37.5
8	(20 – 22)	3.6%	9.4%	7.8%	11.5%	13.1	34.3	28.7	41.8

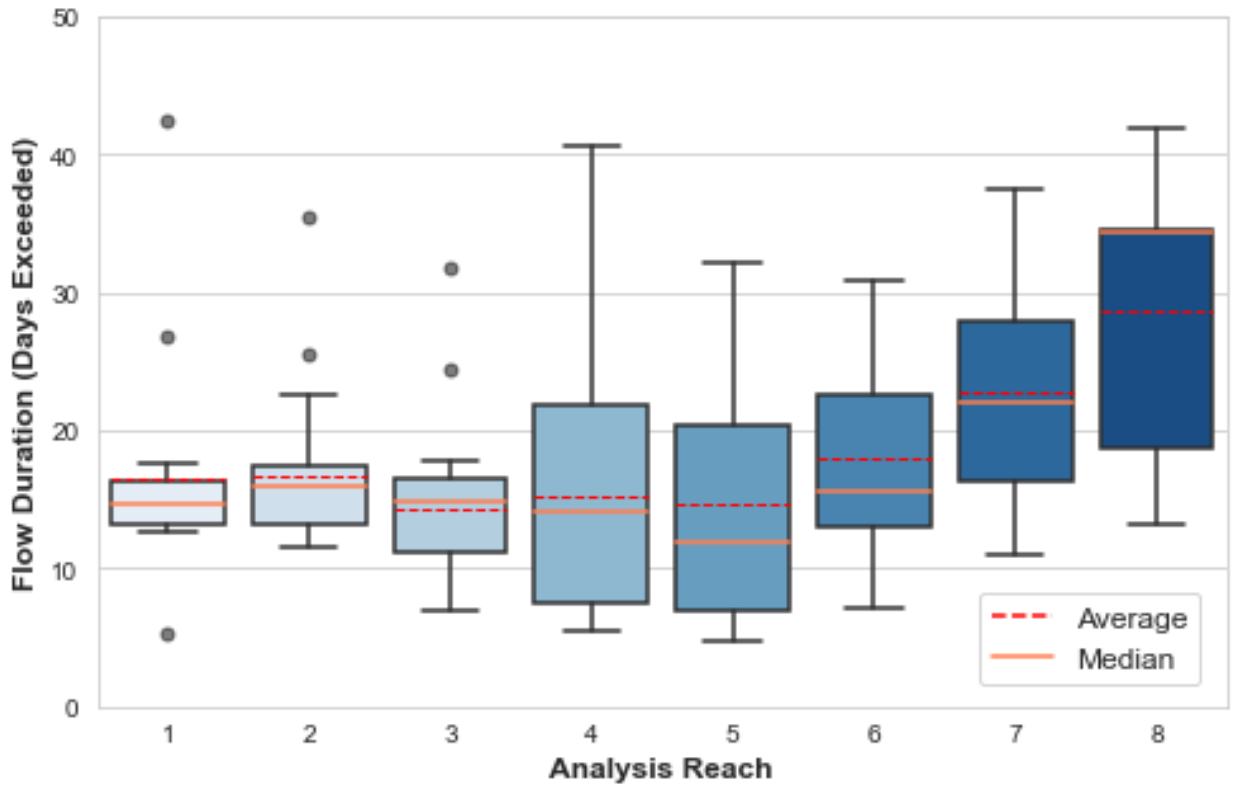

Figure 4-3. Range of bankfull indicator flow duration by model reach.

4.5 Inundation Mapping

The hydraulic model output was used to map potential depth of inundation for the Q1.5, Q2, Q10, Q25 and Q100 discharges. Inundation mapping includes relative elevation mapping only and does not account for features that influence floodplain connection such as levees, bridges, culverts, etc. As such, inundation mapping should not be assumed to represent actual flooding conditions, but rather potential inundation depth relative to modeled water surface elevations in the CFR channel.

Water surface elevations for the Q1.5 and Q2 maps were generated from the model geometry parameterized for near-bankfull flows. Water surface elevations for the Q10, Q25 and Q100 maps were generated from the model geometry parameterized for 100-year flows.

4.6 Recommendations

4.6.1 Potential Model Refinements

The CFR Reach A hydraulic model provides a calibrated, reach-scale model that, with refinements, will be a useful tool for designing remediation and restoration actions in the CFROU. Confidence in model results could be improved with additional data collection and analysis including:

- Refinement of bankfull indicators used for the recurrence interval analysis;
- Additional discharge measurements at stage recorder locations to support stage-discharge rating curve development and timing of tributary inputs;
- Quantification of surface water diversion withdrawals and returns;
- Comparisons of inundation mapping with flood imagery;
- Comparisons of predicted water surface elevations with other design-scale models completed for individual design phases; and
- Additional cross sections.

The wide range of recurrence intervals associated with bank indicators suggests that bankfull indicator selection could be refined. Selection of appropriate indicators was affected by the existing degraded state of CFR Reach A and the lack of suitable reference channel and floodplain conditions. Additional field work could be undertaken to identify more appropriate bankfull indicators that represent desired floodplain conditions.

Two discharge measurements were completed at each stage recorder location and an additional three to five discharge measurements are recommended at each site to establish reasonable stage-discharge relationships. Development of rating curves at stage recorder locations will provide improved information for evaluating the timing and magnitude of tributary inputs and surface water diversion withdrawals.

Discharge measurements suggest that surface water diversions and returns are affecting CFR hydrology. Quantification of diversion withdrawals will improve model hydrology and development of floodplain design criteria.

Comparisons between inundation maps and UAS flood imagery will provide another means for validating model hydrology, model calibration and model accuracy. Comparisons of Reach A model results with other design phase models will provide additional means for validating model inputs and results.

Other items that could improve model performance include additional Wolman pebble counts and cross sections. Additional pebble counts could be used in the lower reaches for refining the channel bed roughness and sediment transport characteristics of those reaches. Additional cross section survey data may be required for capturing river channel geometry near bridges and diversions or areas of poor model performance.

Model performance was tested against a design-scale model developed for the Alvi-Beck irrigation diversion improvement project in order to better understand the magnitude of improvement that could result from adding cross sections to the model. Cross sections for the Alvi-Beck model were surveyed in 2020 prior to improvements at the diversion. Cross section spacing averaged 162 feet for the Alvi-Beck model and 1385 feet for the portion of the Reach A model used for comparison. Flows from the Reach A model were used for the comparison. Differences in channel bed elevations between the Reach A model and the Alvi-Beck model ranged from -2.1 feet to +1.3 feet with an average difference of -0.7 feet and RMS of 1.3 feet. Differences in water surface elevation for the 1.5-year event (576 cfs) ranged from -0.4 feet to +0.4 feet with an average of -0.1 feet and RMS of 0.2 feet. Differences in water surface elevation for the 2-year event (838 cfs) ranged from -0.6 feet to +0.1 feet with an average of -0.3 feet and RMS of 0.3 feet. Statistics are reported in Table 4-6 and profiles shown in Figure 4-4.

Table 4-6. Difference in bed elevation and WSEL from Alvi-Beck model and CFR Reach A model.

Statistic	Δ Bed Elevation	Δ 1.5-year WSEL	Δ Bankfull WSEL	Δ 2-year WSEL
Minimum	-2.1	-0.4	-0.4	-0.6
Average	-0.7	-0.1	-0.1	-0.3
Median	-1.1	-0.1	-0.1	-0.3
Maximum	1.8	0.4	0.3	0.1
RMS	1.3	0.2	0.2	0.3

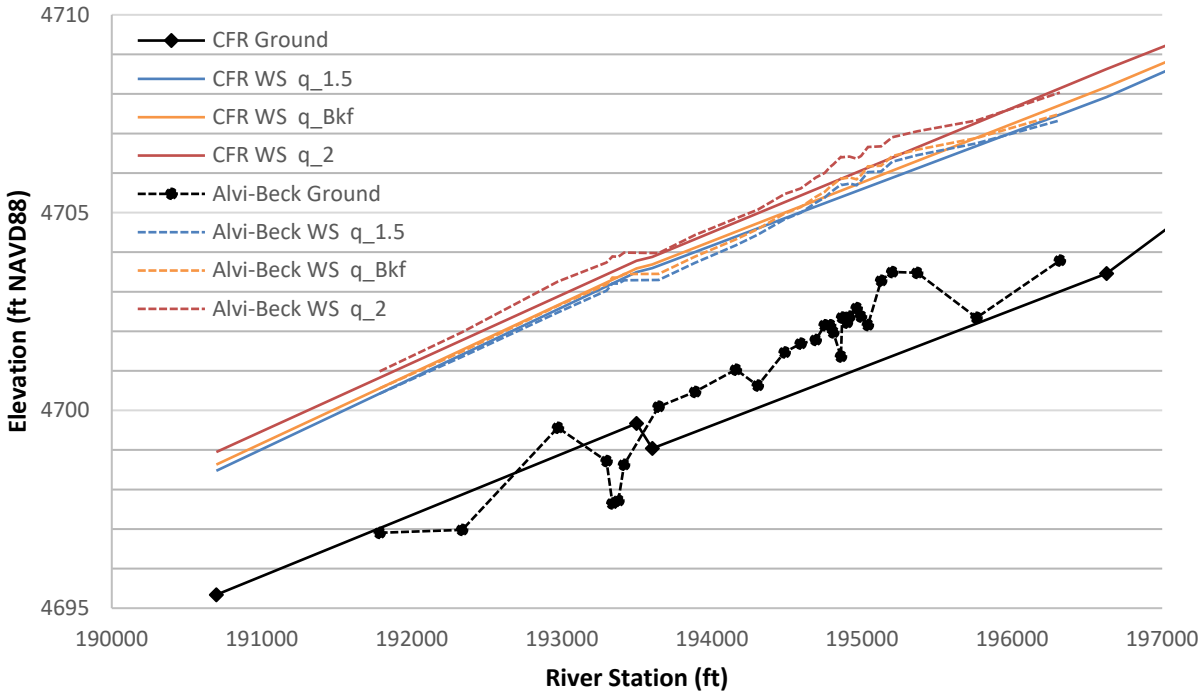

Figure 4-4. Comparison of Alvi-Beck and CFR Reach A model profiles.

4.6.2 Other Uses for CFR Reach A Model

Regarding other potential uses, the CFR Reach A hydraulic model could provide a reach-scale framework for evaluating effects of channel geometry on floodplain connection, sediment mobility and sediment transport continuity. The Reach A hydraulic model also provides information for establishing boundary conditions for other models including phase-scale design models, unsteady flow simulations and two-dimensional floodplain models. Such design-scale models could be useful for evaluating the effectiveness of in-stream and floodplain treatments aimed at providing hydraulic complexity and improved floodplain function.

From a design perspective, use of recurrence intervals, bankfull indicators and modeled water surface elevations should be supplemented with additional design criteria to optimize floodplain function and revegetation success. Ecological, biological and geomorphic design elements that provide complexity, diversity and disturbance are equally important for establishing resilient floodplain conditions and can be highly effective when combined with design criteria provided by hydraulic models. In addition, in-stream design elements that influence floodplain connectivity, roughness and sediment transport may also contribute to improved floodplain function.

5 References

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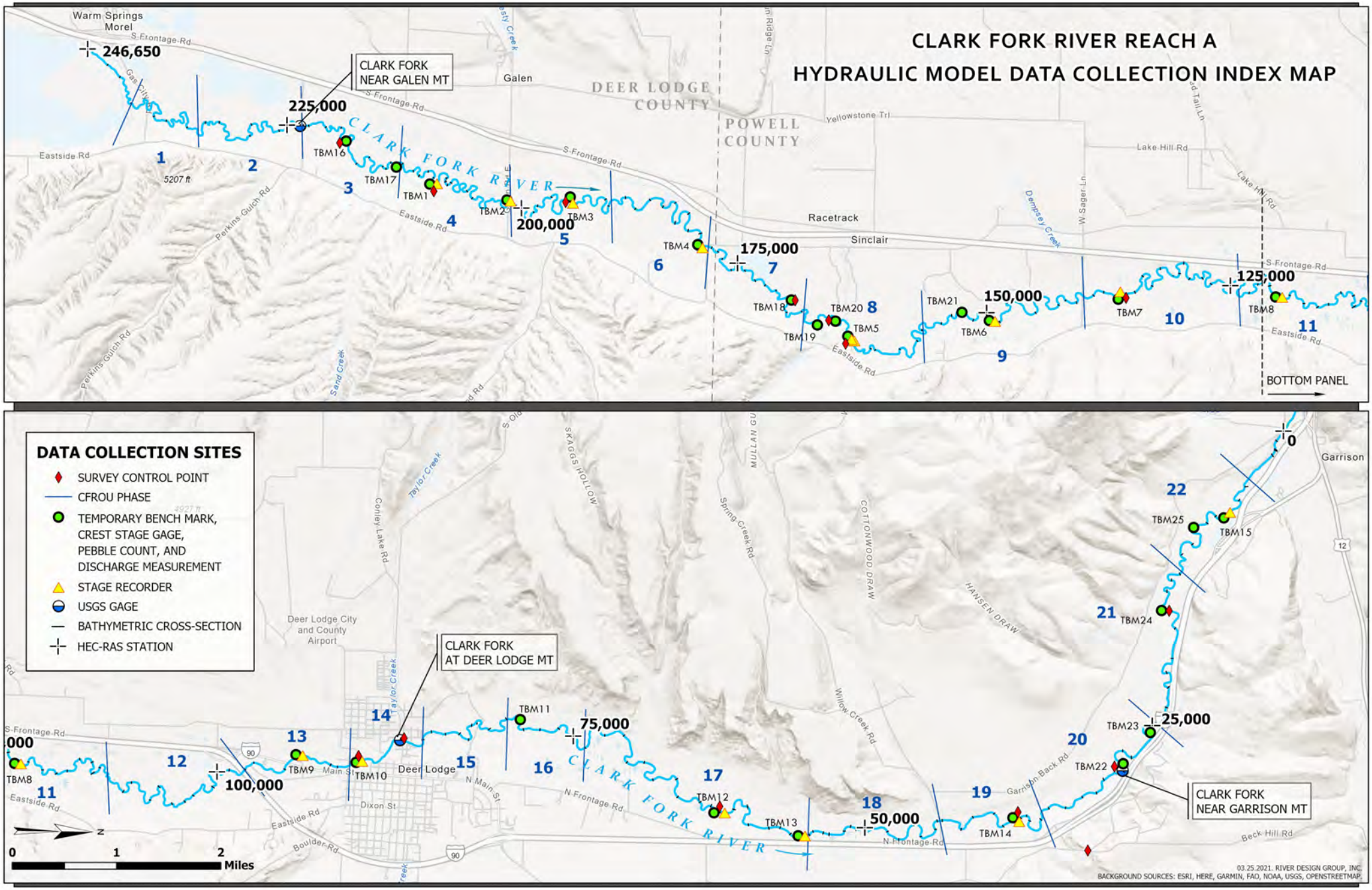
APPENDIX A – DATA COLLECTION SUMMARY


CLARK FORK RIVER REACH A
HYDRAULIC MODEL DATA COLLECTION INDEX MAP
DATA COLLECTION SITES
SURVEY CONTROL POINT
CFROU PHASE
TEMPORARY BENCH MARK, CREST STAGE GAGE, PEBBLE COUNT, AND DISCHARGE MEASUREMENT
STAGE RECORDER
USGS GAGE
BATHYMETRIC CROSS-SECTION
HEC-RAS STATION
246,650
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
CLARK FORK NEAR GALEN MT
CLARK FORK AT DEER LODGE MT
CLARK FORK NEAR GARRISON MT
CLARK FORK RIVER
TBM1
TBM2
TBM3
TBM4
TBM5
TBM6
TBM7
TBM8
TBM9
TBM10
TBM11
TBM12
TBM13
TBM14
TBM15
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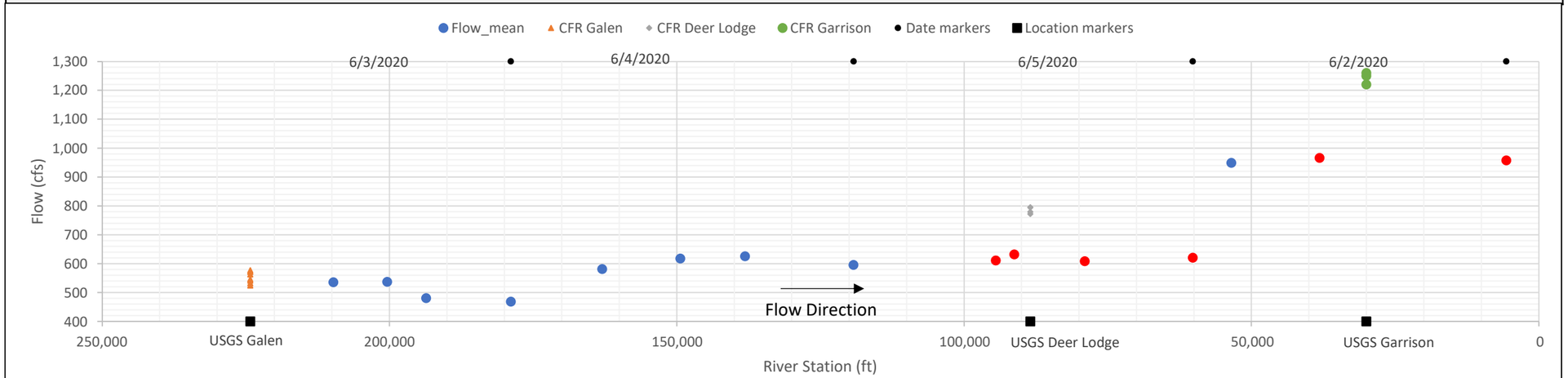
TBM17
TBM18
TBM19
TBM20
TBM21
TBM22
TBM23
TBM24
TBM25
Warm Springs
Morel
Galen
DEER LODGE COUNTY
POWELL COUNTY
Racetrack
Sinclair
Deer Lodge
Garrison
Deer Lodge City and County Airport
S Frontage Rd
Eastside Rd
Perkins Gulch Rd
Sand Creek
Taylor Creek
Conley Lake Rd
Spring Creek Rd
Willow Creek Rd
Dixon St
Main St
N Main St
N Frontage Rd
Garrison Back Rd
Beck Hill Rd
Boulder Rd
Lake Hill Rd
Yellowstone Trl
Dempsey Creek
W Sager Ln
Mullan Gulch
Skaggs Hollow
Cottonwood Draw
Hansen Draw
BOTTOM PANEL
0 1 2 Miles
03.25.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP,

A-2. Near-bankfull discharge measurement data. Suspect measurements shown in red.

Site	TBM 1	TBM 2	TBM 3	TBM 4	TBM 5	TBM 6	TBM 7	TBM 8	TBM 9	TBM 10	TBM 11	TBM 12	TBM 13	TBM 14	TBM 15
Date	6/3/2020	6/3/2020	6/3/2020	6/3/2020	6/4/2020	6/4/2020	6/4/2020	6/4/2020	6/5/2020	6/5/2020	6/5/2020	6/5/2020	6/2/2020	6/2/2020	6/2/2020
Time	12:15	13:45	14:45	16:45	11:45	13:45	15:30	17:00	10:15	11:30	13:15	15:15	12:00	14:15	18:00
Measurement 1	524	528	446	493	601	618	658	539	612	636	590	645	971	939	947
Measurement 2	531	554	440	460	509	630	607	633	609	624	656	591	928	980	986
Measurement 3	539	530	488	433	608	617	644	565	599	648	581	641	940	941	936
Measurement 4	529	538	505	494	571	606	590	618	624	620	624	566	953	979	960
Measurement 5	552	540	481	466	632	621	633	597		650	578	653	949	990	
Measurement 6	537	534	521	467	565	614	621	618		610	663	627	954		
Measurement 7			488		609						567				
Measurement 8			477		585										
Measurement 9					636										
Measurement 10					592										
Summary Statistics															
Mean	535	537	481	469	581	618	626	595	611	631	608	621	949	966	957
Std Dev	10	9	27	23	37	8	25	36	10	16	39	35	14	24	22
Std Err	4.0	3.8	9.6	9.3	11.7	3.2	10.1	14.8	5.1	6.5	14.8	14.1	5.9	10.7	10.8
UCL (95%)	543	545	500	487	604	624	645	624	621	644	637	648	961	987	978
LCL (95%)	527	530	462	451	558	611	606	566	601	619	579	593	938	945	936
USGS Gage Flow Estimates															
CFR Galen	577	572	572	563	546	541	532	524							
CFR Deer Lodge									772	779	795	795			
CFR Garrison													1260	1250	1220



A-3. CFR Reach A low flow discharge measurement summary. Suspect measurements shown in red.

Site ID	TBM16	TBM17	TBM1	TBM2	TBM3	TBM4	TBM18	TBM19	TBM20	TBM5	TBM21	TBM6	TBM7	TBM8	TBM9	TBM10	TBM11	TBM12	TBM13	TBM14	TBM22	TBM23	TBM24	TBM25	TBM15
River Station	220,065	213,732	209,739	200,391	193,602	178,881	170,548	166,791	165,108	162,979	151,779	151,052	138,112	119,232	94,467	91,261	78,985	60,190	53,491	38,110	30,012	25,207	16,965	7,846	5,633
Measurement (cfs)	55.1	160.9	212.7	163.1	206.1	210.9	212.4	190.9	54.7	226.7	115.3	208.8	121.9	245.8	158.5	231.9	259.0	262.8	266.5	283.0	154.0	123.3	129.2	116.9	274.5
Date	4/22	4/22	4/23	3/22	4/21	4/22	4/18	4/18	4/19	4/19	4/20	4/20	4/17	4/3	4/10	4/8	4/7	4/7	4/5	4/4	3/23	4/5	3/24	3/24	3/24
Time	12:40	2:55	10:20	3:15	12:15	8:35	11:56	2:33	10:23	1:55	11:45	1:04	4:30	2:40	4:15	3:00	4:50	11:10	5:04	13:53	2:40	1:36	3:00	1:37	4:20
CFR Galen	169	161	178	120	163	172	149	160	150	149	155	150	171												
CFR Deer Lodge														290	300	290	285	285							
CFR Garrison																			290	290	276	285	280	280	276

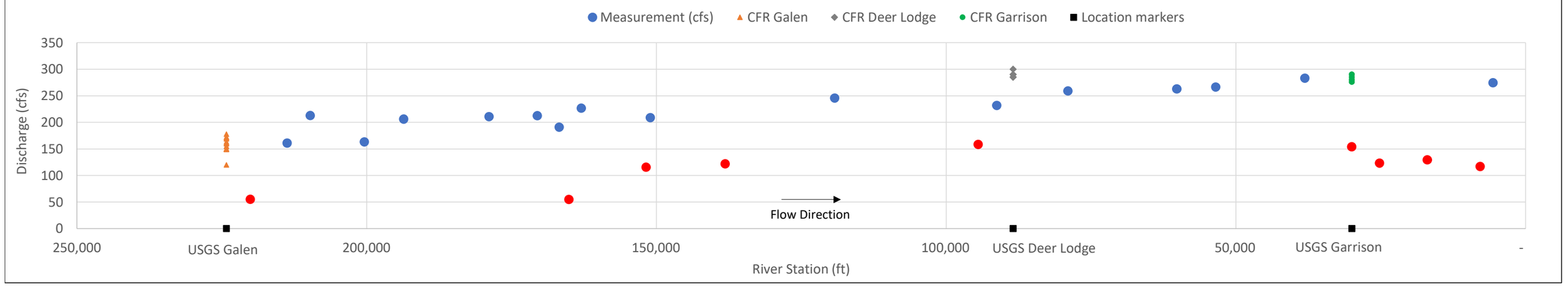
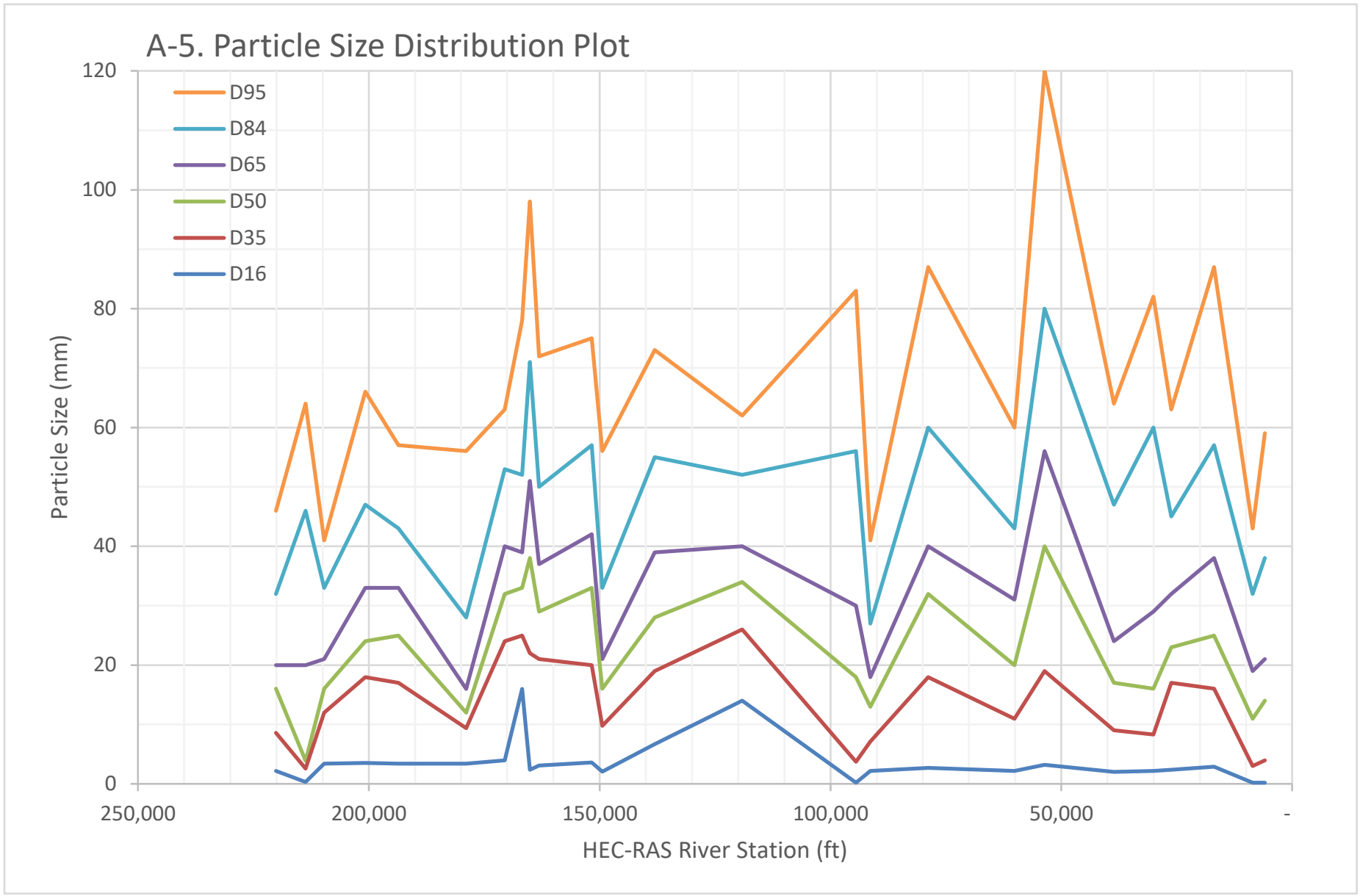


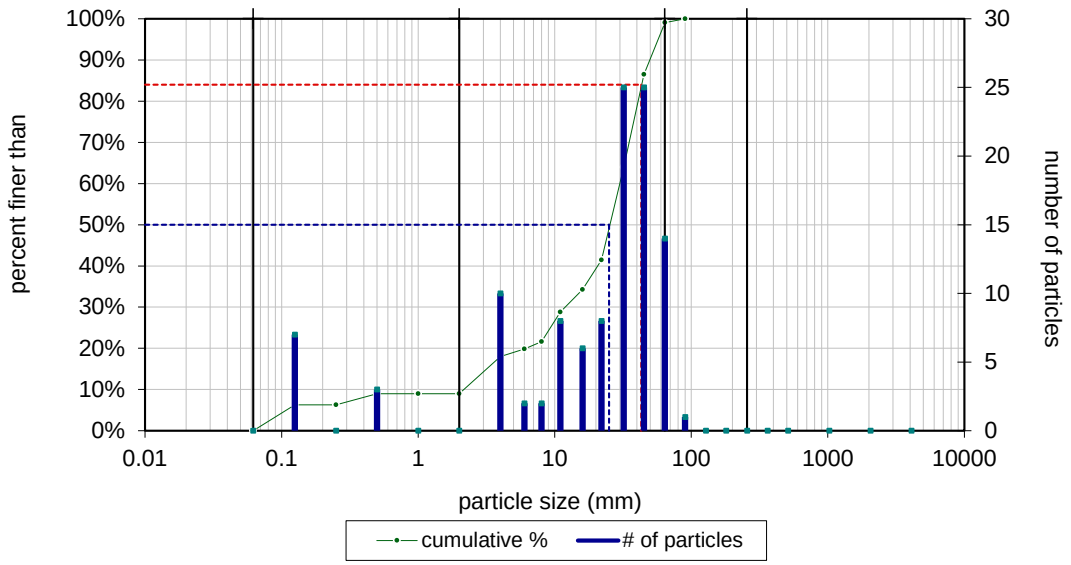
Table A-4. Pebble count data summary.

Station	Section ID	Material Size (mm)																			Particles Size Distribuition									% Particles by Type				
		silt/clay	very fine sand	fine sand	medium sand	coarse sand	very coarse sand	very fine gravel	fine gravel	fine gravel	medium gravel	medium gravel	coarse gravel	coarse gravel	very coarse gravel	very coarse gravel	small cobble	medium cobble	large cobble	total particle count:	D16	D35	D50	D65	D84	D95	mean	disper-sion	skew-ness	silt/clay	sand	gravel	cobble	boulder
		0 - 0.062	0.062 - 0.125	0.125 - 0.25	0.25 - 0.5	0.5 - 1	1 - 2	2 - 4	4 - 6	6 - 8	8 - 11	11 - 16	16 - 22	22 - 32	32 - 45	45 - 64	64 - 90	90 - 128	128 - 180																
220,086	TBM 16	8	0	11	0	0	0	19	4	3	10	12	32	15	14	4	3	0	0	135	2.2	8.6	16	20	32	46	8.39	4.64	-0.26	6%	8%	84%	2%	0%
213,718	TBM 17	4	0	15	16	0	0	40	6	0	5	4	7	11	14	17	6	1	0	146	0.3	2.6	3.9	20	46	64	3.71	12.40	-0.01	3%	21%	71%	5%	0%
209,673	TBM 1	8	0	2	0	0	0	11	0	4	11	20	21	19	19	1	0	0	0	116	3.4	12	16	21	33	41	10.59	3.38	-0.18	7%	2%	91%	0%	0%
200,799	TBM 2	1	0	9	0	0	0	10	3	1	2	9	16	20	22	14	5	1	0	113	3.5	18	24	33	47	66	12.83	4.41	-0.26	1%	8%	86%	5%	0%
193,557	TBM 3	0	7	0	3	0	0	10	2	2	8	6	8	25	25	14	1	0	0	111	3.4	17	25	33	43	57	12.09	4.54	-0.30	0%	9%	90%	1%	0%
178,934	TBM 4	2	0	8	0	0	0	10	3	6	20	24	17	5	8	4	3	1	0	111	3.4	9.4	12	16	28	56	9.76	2.93	-0.09	2%	7%	87%	4%	0%
170,570	TBM 18	5	0	4	0	0	0	9	1	0	3	3	9	21	27	25	5	0	0	112	4	24	32	40	53	63	14.56	4.83	-0.32	4%	4%	88%	4%	0%
166,769	TBM 19	1	0	2	0	0	0	3	0	3	4	5	12	23	34	14	6	1	2	110	16	25	33	39	52	78	28.84	1.82	-0.08	1%	2%	89%	8%	0%
165,125	TBM 20	8	0	7	0	0	0	15	0	1	2	1	8	9	18	27	16	8	0	120	2.4	22	38	51	71	98	13.05	8.85	-0.38	7%	6%	68%	20%	0%
163,121	TBM 5	6	0	5	0	0	0	11	3	0	4	1	10	22	27	16	4	1	2	112	3.1	21	29	37	50	72	12.45	5.54	-0.33	5%	4%	84%	6%	0%
151,754	TBM 21	2	0	8	0	0	0	10	2	2	3	7	10	11	25	24	11	0	0	115	3.6	20	33	42	57	75	14.32	5.45	-0.33	2%	7%	82%	10%	0%
149,432	TBM 6	9	0	10	0	0	0	13	2	3	10	14	23	19	9	9	2	1	0	124	2.1	9.8	16	21	33	56	8.32	4.84	-0.26	7%	8%	82%	2%	0%
138,106	TBM 7	0	0	7	0	0	0	7	2	4	8	4	11	18	19	21	9	0	0	110	6.7	19	28	39	55	73	19.20	3.07	-0.17	0%	6%	85%	8%	0%
119,155	TBM 8	0	0	0	0	0	0	5	0	0	7	6	11	14	32	22	3	0	0	100	14	26	34	40	52	62	26.98	1.98	-0.13	0%	0%	97%	3%	0%
94,495	TBM 9	5	0	20	0	0	0	25	0	2	3	9	14	12	15	15	12	4	0	136	0.2	3.7	18	30	56	83	3.51	42.46	-0.46	4%	15%	70%	12%	0%
91,338	TBM 10	6	0	0	11	0	0	17	4	6	11	12	24	17	7	3	1	0	0	119	2.2	7.1	13	18	27	41	7.71	3.99	-0.22	5%	9%	85%	1%	0%
78,833	TBM 11	1	0	12	0	0	0	13	4	1	4	4	6	14	25	18	10	5	0	117	2.7	18	32	40	60	87	12.73	6.86	-0.35	1%	10%	76%	13%	0%
60,139	TBM 12	4	0	13	0	0	0	17	0	3	4	11	12	14	26	11	4	0	0	119	2.2	11	20	31	43	60	9.73	5.62	-0.28	3%	11%	82%	3%	0%
53,644	TBM 13	1	0	10	0	0	0	11	0	2	6	4	10	3	16	18	22	7	4	114	3.2	19	40	56	80	120	16.00	7.25	-0.34	1%	9%	61%	29%	0%
38,624	TBM 14	9	0	10	0	0	0	14	3	2	11	6	19	14	11	15	6	0	0	120	2	9	17	24	47	64	9.70	5.63	-0.21	8%	8%	79%	5%	0%
16,968	TBM 24	4	0	14	0	0	0	18	5	3	6	14	13	8	12	13	16	2	0	128	2.2	8.3	16	29	60	82	11.49	5.51	-0.12	3%	11%	72%	14%	0%
8,567	TBM 23/XS26	5	0	12	0	0	0	17	0	1	3	7	18	25	25	15	5	0	1	134	2.4	17	23	32	45	63	10.39	5.77	-0.31	4%	9%	83%	4%	0%
8,567	TBM 25	4	0	8	0	0	0	12	1	1	5	9	12	13	19	17	8	5	0	114	2.9	16	25	38	57	87	12.86	5.45	-0.25	4%	7%	78%	11%	0%
8,567	XS 28 & 29	5	0	24	0	0	0	29	0	2	6	11	16	18	18	4	0	0	0	133	0.2	3	11	19	32	43	2.53	28.95	-0.43	4%	18%	78%	0%	0%
5,946	TBM 15	9	0	13	0	0	0	22	2	3	8	10	17	13	15	9	2	2	0	125	0.2	4	14	21	38	59	2.89	33.18	-0.46	7%	10%	79%	3%	0%
	SUM	107	7	224	30	0	0	368	47	55	164	213	356	383	482	350	160	39	9	2994															
	AVERAGE	4.28	0.28	8.96	1.2	0	0	14.7	1.88	2.2	6.56	8.52	14.2	15.3	19.3	14	6.4	1.56	0.36	120	2.5	12	21	32	49	72	11.07	5.37	-0.24	4%	9%	81%	7%	0%
	MIN	0	0	0	0	0	0	3	0	0	2	1	6	3	7	1	0	0	0	100	0.2	3	11	16	27	41	2.53	1.82	-0.46	0%	0%	61%	0%	0%
	MEDIAN	4	0	8	0	0	0	12	2	2	6	7	12	14	19	15	5	1	0	116	2.9	17	24	33	50	64	12.09	5.45	-0.28	4%	8%	82%	5%	0%
	MAX	9	7	24	11	0	0	29	5	6	20	24	24	25	34	27	22	8	4	136	16	26	40	56	80	120	28.84	42.46	-0.08	8%	18%	97%	29%	0%


A-5. Particle Size Distribution Plot
D95
D84
D65
D50
D35
D16
Particle Size (mm)
120
100
80
60
40
20
0
250,000
200,000
150,000
100,000
50,000
-
HEC-RAS River Station (ft)

Counter:	KJ	**Section ID:**	TBM 3
Recorder:	JL	**Date:**	4/11/2020
Location:	CFR	**Time:**	3:25 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**0**
very fine sand	0.062 - 0.125	**7**
fine sand	0.125 - 0.25	**0**
medium sand	0.25 - 0.5	**3**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**8**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**25**
very coarse gravel	32 - 45	**25**
very coarse gravel	45 - 64	**14**
small cobble	64 - 90	**1**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**111**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**111**

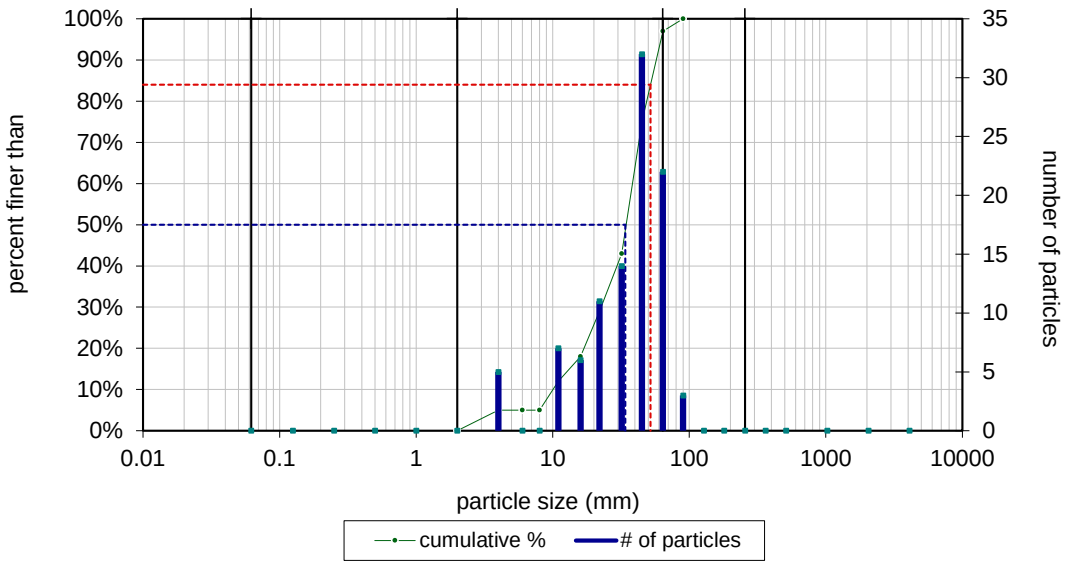


Size (mm & in)			Size Distribution		Type	
D_{16}	3.4	0.1	mean	12.1	silt/clay	0%
D_{35}	17	0.7	dispersion	4.5	sand	9%
D_{50}	25	1.0	skewness	-0.30	gravel	90%
D_{65}	33	1.3			cobble	1%
D_{84}	43	1.7			boulder	0%
D_{95}	57	2.2				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 8
Recorder:	CF	**Date:**	4/3/2020
Location:	CFR REACH A	**Time:**	3:30 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	0
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	5
fine gravel	4 - 6	0
fine gravel	6 - 8	0
medium gravel	8 - 11	7
medium gravel	11 - 16	6
coarse gravel	16 - 22	11
coarse gravel	22 - 32	14
very coarse gravel	32 - 45	32
very coarse gravel	45 - 64	22
small cobble	64 - 90	3
medium cobble	90 - 128	0
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**100**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**100**

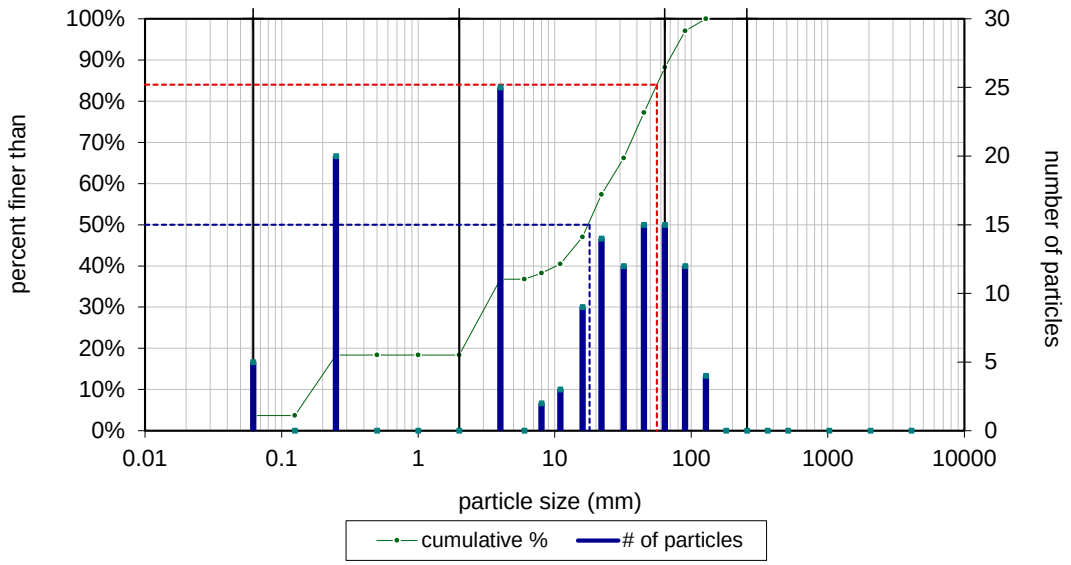


Size (mm & in)			Size Distribution		Type	
D_{16}	14	0.6	mean	27.0	silt/clay	0%
D_{35}	26	1.0	dispersion	2.0	sand	0%
D_{50}	34	1.3	skewness	-0.13	gravel	97%
D_{65}	40	1.6			cobble	3%
D_{84}	52	2.0			boulder	0%
D_{95}	62	2.4				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 9
Recorder:	CF	**Date:**	4/8/2020
Location:	CFR	**Time:**	4:50 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**20**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**25**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**12**
very coarse gravel	32 - 45	**15**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**12**
medium cobble	90 - 128	**4**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		**136**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**136**

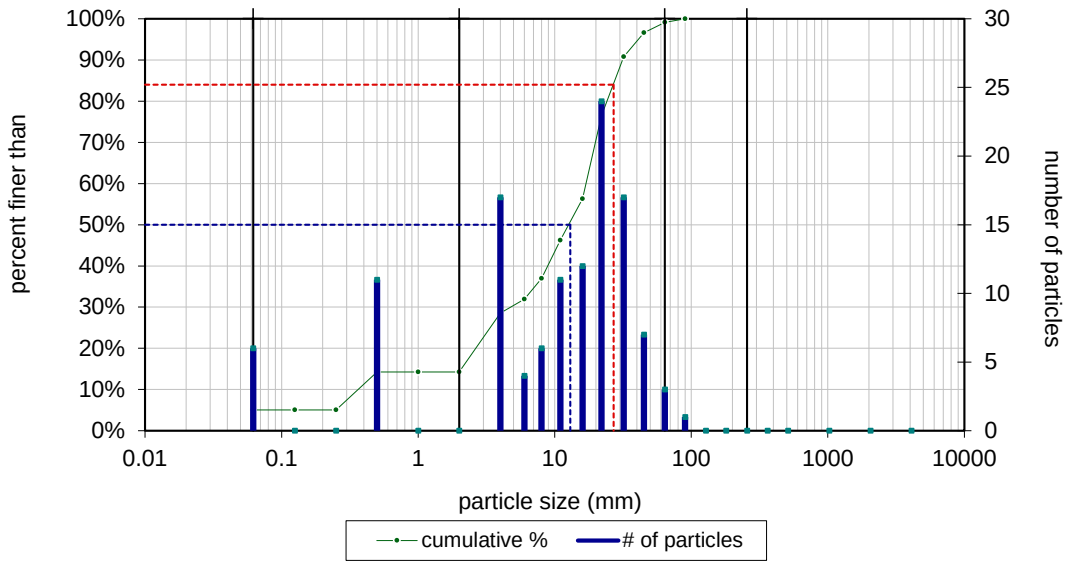


Size (mm & in)			Size Distribution		Type	
D_{16}	0.22	0.0	mean	3.5	silt/clay	4%
D_{35}	3.7	0.1	dispersion	42.5	sand	15%
D_{50}	18	0.7	skewness	-0.46	gravel	70%
D_{65}	30	1.2			cobble	12%
D_{84}	56	2.2			boulder	0%
D_{95}	83	3.3				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 10
Recorder:	CF	**Date:**	4/8/2020
Location:	CFR	**Time:**	4:15 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	6
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	11
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	17
fine gravel	4 - 6	4
fine gravel	6 - 8	6
medium gravel	8 - 11	11
medium gravel	11 - 16	12
coarse gravel	16 - 22	24
coarse gravel	22 - 32	17
very coarse gravel	32 - 45	7
very coarse gravel	45 - 64	3
small cobble	64 - 90	1
medium cobble	90 - 128	0
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**119**
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		**119**

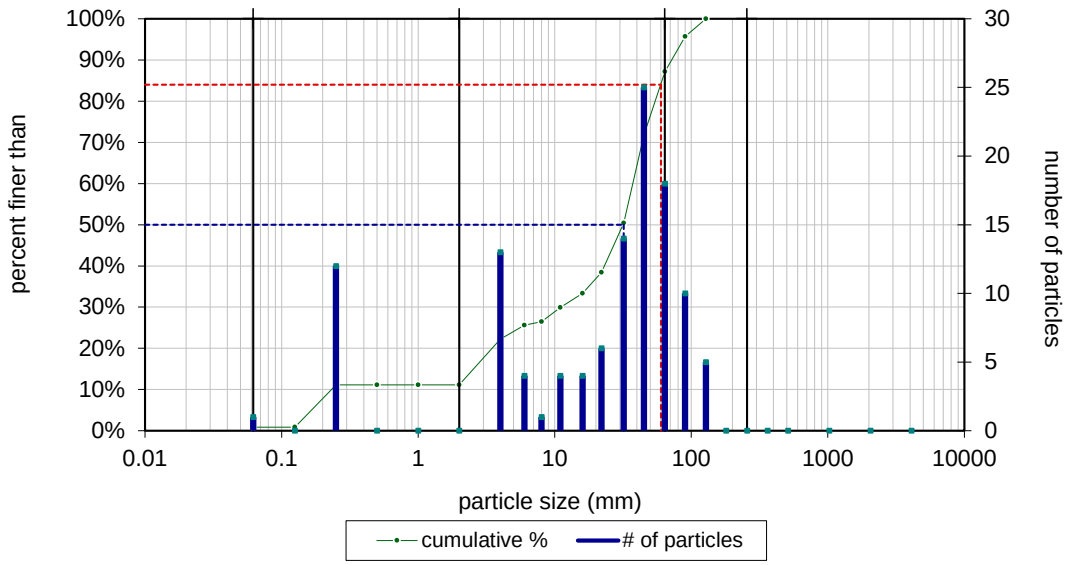


Size (mm & in)			Size Distribution		Type	
D_{16}	2.2	0.1	mean	7.7	silt/clay	5%
D_{35}	7.1	0.3	dispersion	4.0	sand	9%
D_{50}	13	0.5	skewness	-0.22	gravel	85%
D_{65}	18	0.7			cobble	1%
D_{84}	27	1.1			boulder	0%
D_{95}	41	1.6				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 11
Recorder:	CF	**Date:**	4/7/2020
Location:	CFR	**Time:**	3:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	12
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	13
fine gravel	4 - 6	4
fine gravel	6 - 8	1
medium gravel	8 - 11	4
medium gravel	11 - 16	4
coarse gravel	16 - 22	6
coarse gravel	22 - 32	14
very coarse gravel	32 - 45	25
very coarse gravel	45 - 64	18
small cobble	64 - 90	10
medium cobble	90 - 128	5
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		117
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		117

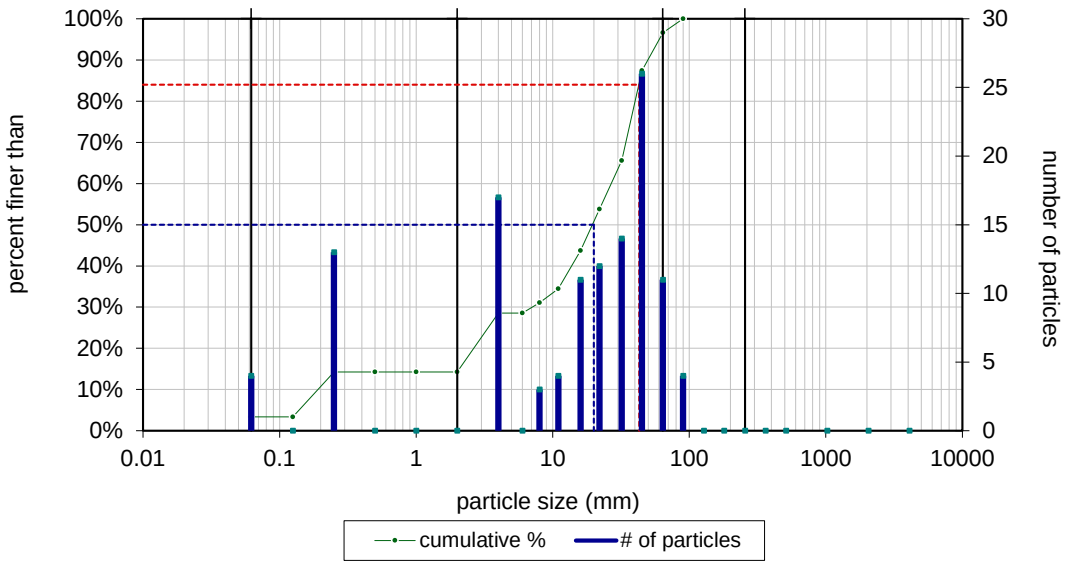


Size (mm & in)			Size Distribution		Type	
D_{16}	2.7	0.1	mean	12.7	silt/clay	1%
D_{35}	18	0.7	dispersion	6.9	sand	10%
D_{50}	32	1.3	skewness	-0.35	gravel	76%
D_{65}	40	1.6			cobble	13%
D_{84}	60	2.4			boulder	0%
D_{95}	87	3.4				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 12
Recorder:	CF	**Date:**	4/7/2020
Location:	CFR	**Time:**	12:15 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**4**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**13**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**17**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**11**
coarse gravel	16 - 22	**12**
coarse gravel	22 - 32	**14**
very coarse gravel	32 - 45	**26**
very coarse gravel	45 - 64	**11**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		**119**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**119**

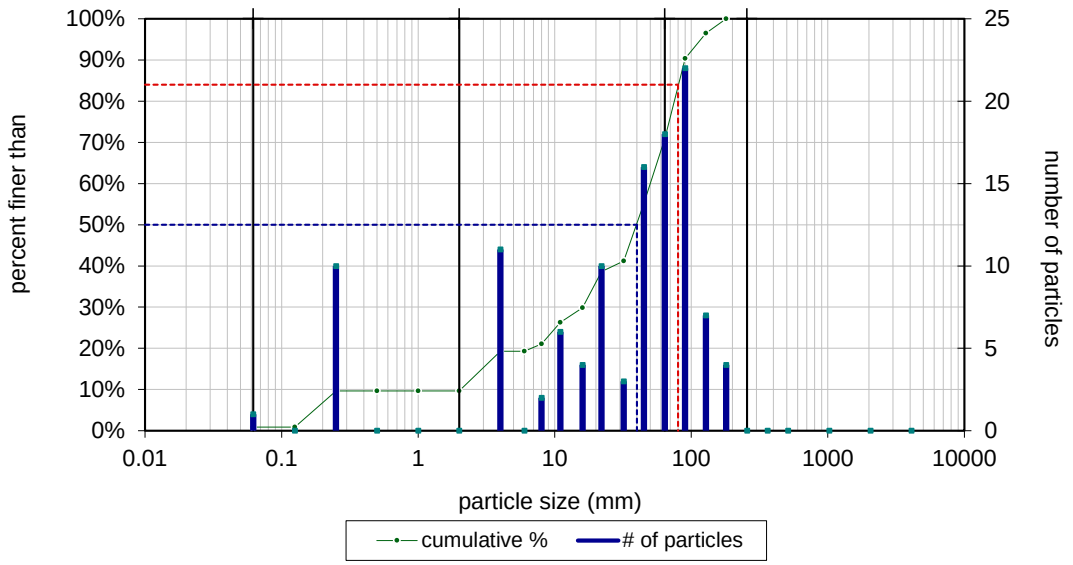


Size (mm & in)			Size Distribution		Type	
D_{16}	2.2	0.1	mean	9.7	silt/clay	3%
D_{35}	11	0.4	dispersion	5.6	sand	11%
D_{50}	20	0.8	skewness	-0.28	gravel	82%
D_{65}	31	1.2			cobble	3%
D_{84}	43	1.7			boulder	0%
D_{95}	60	2.4				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 13
Recorder:	CF	**Date:**	4/5/2020
Location:	CFR	**Time:**	3:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	10
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	11
fine gravel	4 - 6	0
fine gravel	6 - 8	2
medium gravel	8 - 11	6
medium gravel	11 - 16	4
coarse gravel	16 - 22	10
coarse gravel	22 - 32	3
very coarse gravel	32 - 45	16
very coarse gravel	45 - 64	18
small cobble	64 - 90	22
medium cobble	90 - 128	7
large cobble	128 - 180	4
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		114
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		114

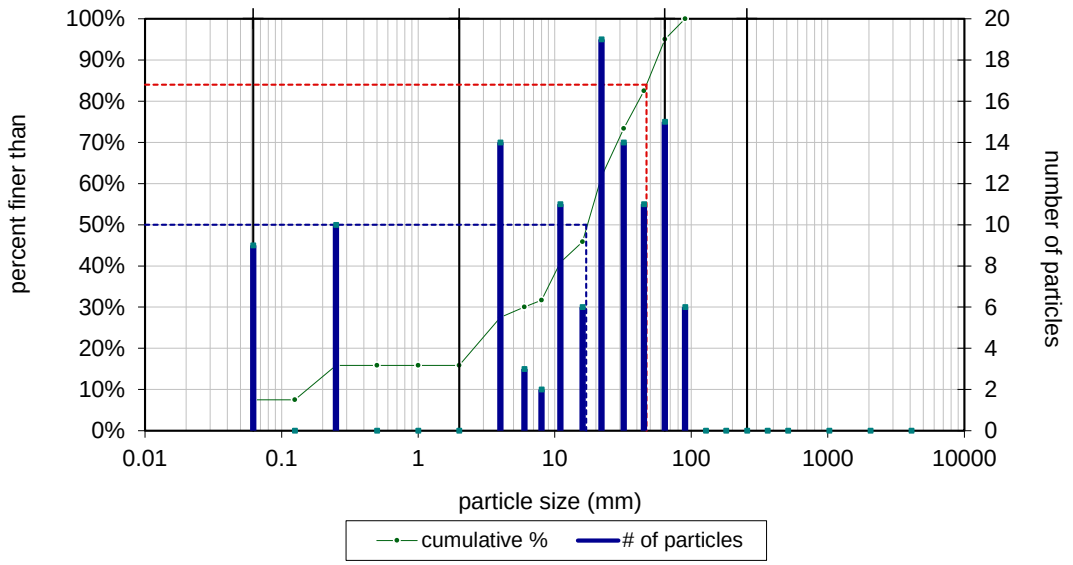


Size (mm & in)			Size Distribution		Type	
D_{16}	3.2	0.1	mean	16.0	silt/clay	1%
D_{35}	19	0.7	dispersion	7.3	sand	9%
D_{50}	40	1.6	skewness	-0.34	gravel	61%
D_{65}	56	2.2			cobble	29%
D_{84}	80	3.1			boulder	0%
D_{95}	120	4.7				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 14
Recorder:	CF	**Date:**	4/4/2020
Location:	CFR	**Time:**	2:55 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**9**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**10**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**14**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**11**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**19**
coarse gravel	22 - 32	**14**
very coarse gravel	32 - 45	**11**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**6**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**120**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**120**

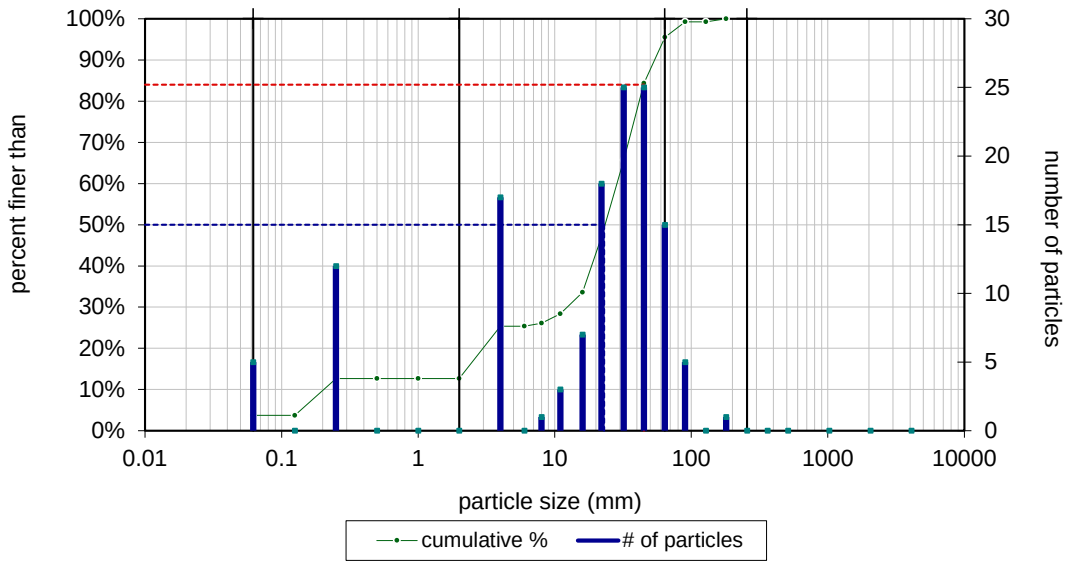


Size (mm & in)			Size Distribution		Type	
D_{16}	2	0.1	mean	9.7	silt/clay	8%
D_{35}	9	0.4	dispersion	5.6	sand	8%
D_{50}	17	0.7	skewness	-0.21	gravel	79%
D_{65}	24	0.9			cobble	5%
D_{84}	47	1.9			boulder	0%
D_{95}	64	2.5				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 23/XS26
Recorder:	CF	**Date:**	4/5/2020
Location:	CFR	**Time:**	1:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**12**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**17**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**18**
coarse gravel	22 - 32	**25**
very coarse gravel	32 - 45	**25**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**5**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**1**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**134**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**134**

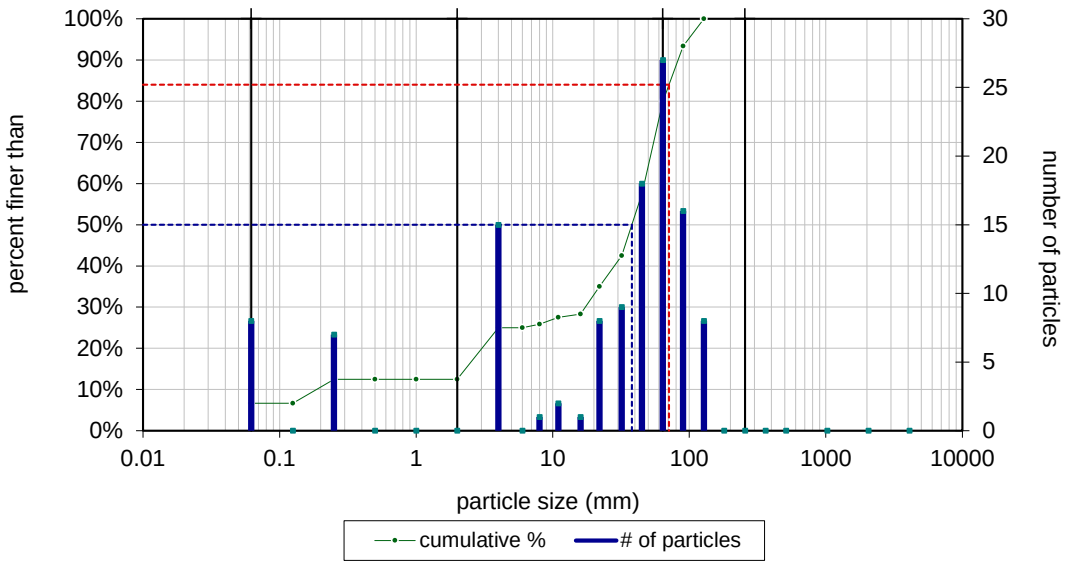


Size (mm & in)			Size Distribution		Type	
D_{16}	2.4	0.1	mean	10.4	silt/clay	4%
D_{35}	17	0.7	dispersion	5.8	sand	9%
D_{50}	23	0.9	skewness	-0.31	gravel	83%
D_{65}	32	1.3			cobble	4%
D_{84}	45	1.8			boulder	0%
D_{95}	63	2.5				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 20
Recorder:	CF	**Date:**	4/19/2020
Location:	CFR	**Time:**	11:15 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**8**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**7**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**15**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**2**
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**9**
very coarse gravel	32 - 45	**18**
very coarse gravel	45 - 64	**27**
small cobble	64 - 90	**16**
medium cobble	90 - 128	**8**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**120**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**120**

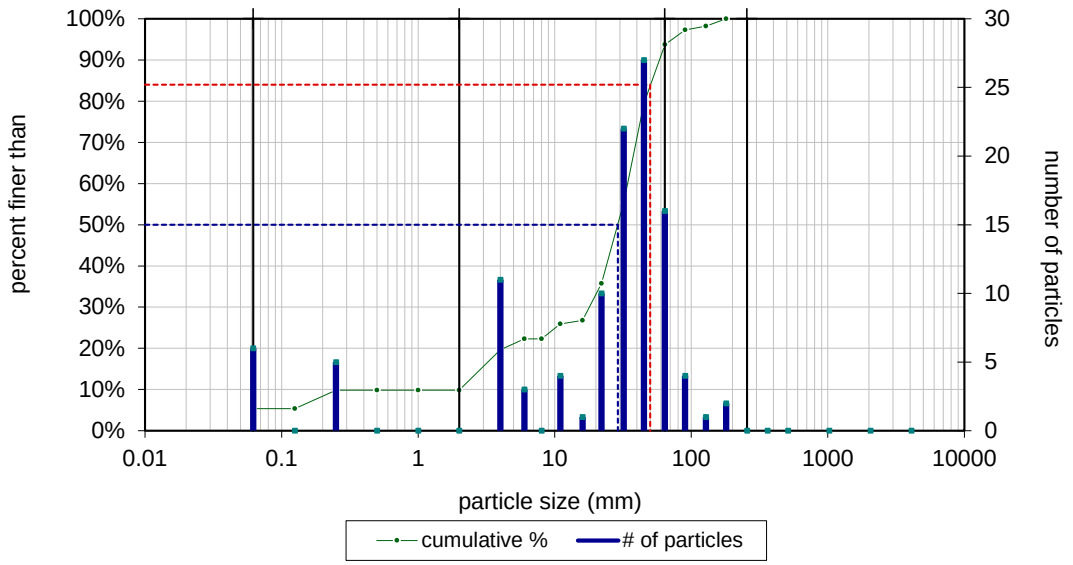


Size (mm & in)			Size Distribution		Type	
D_{16}	2.4	0.1	mean	13.1	silt/clay	7%
D_{35}	22	0.9	dispersion	8.9	sand	6%
D_{50}	38	1.5	skewness	-0.38	gravel	68%
D_{65}	51	2.0			cobble	20%
D_{84}	71	2.8			boulder	0%
D_{95}	98	3.9				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 5
Recorder:	CF	**Date:**	4/19/2020
Location:	CFR	**Time:**	12:00 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**6**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**5**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**11**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**0**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**22**
very coarse gravel	32 - 45	**27**
very coarse gravel	45 - 64	**16**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**2**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**112**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**112**

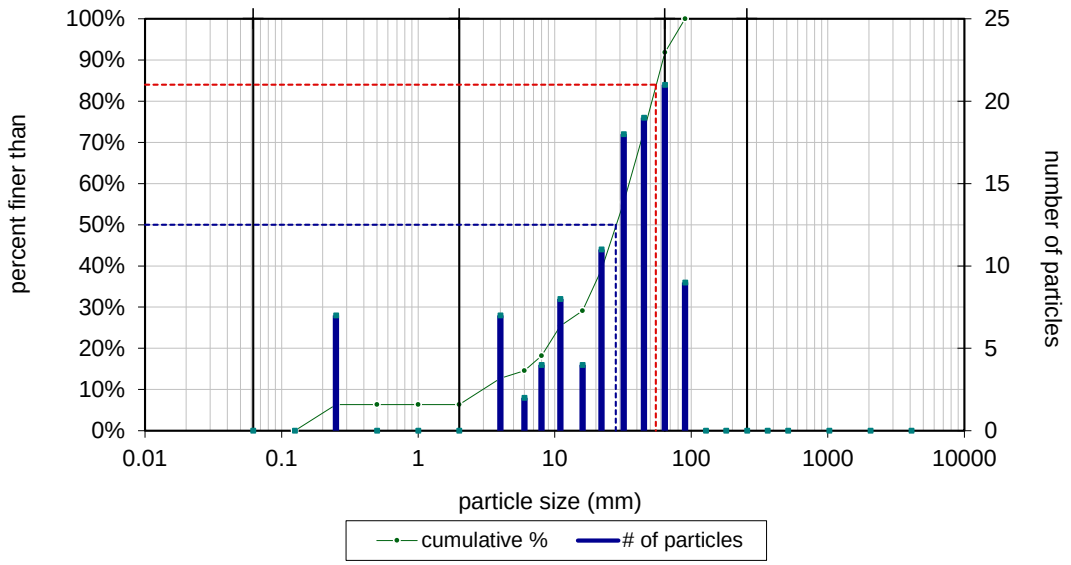


Size (mm & in)			Size Distribution		Type	
D_{16}	3.1	0.1	mean	12.4	silt/clay	5%
D_{35}	21	0.8	dispersion	5.5	sand	4%
D_{50}	29	1.1	skewness	-0.33	gravel	84%
D_{65}	37	1.5			cobble	6%
D_{84}	50	2.0			boulder	0%
D_{95}	72	2.8				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 7
Recorder:	CF	**Date:**	4/17/2020
Location:	CFR	**Time:**	4:00 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**0**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**7**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**7**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**8**
medium gravel	11 - 16	**4**
coarse gravel	16 - 22	**11**
coarse gravel	22 - 32	**18**
very coarse gravel	32 - 45	**19**
very coarse gravel	45 - 64	**21**
small cobble	64 - 90	**9**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**110**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**110**

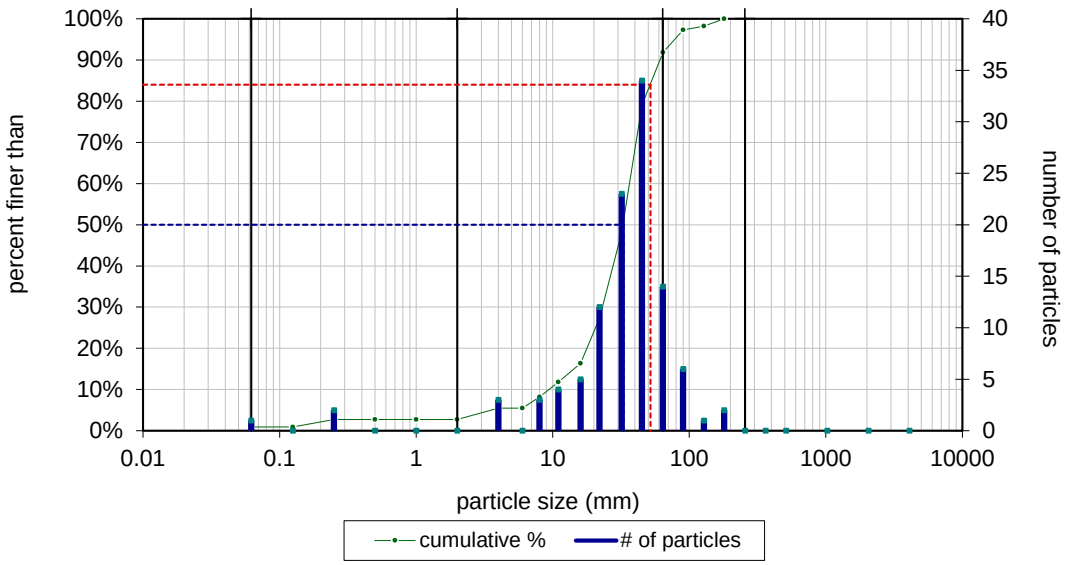


Size (mm & in)			Size Distribution		Type	
D_{16}	6.7	0.3	mean	19.2	silt/clay	0%
D_{35}	19	0.7	dispersion	3.1	sand	6%
D_{50}	28	1.1	skewness	-0.17	gravel	85%
D_{65}	39	1.5			cobble	8%
D_{84}	55	2.2			boulder	0%
D_{95}	73	2.9				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 19
Recorder:	CF	**Date:**	4/18/2020
Location:	CFR	**Time:**	3:30 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	2
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	3
fine gravel	4 - 6	0
fine gravel	6 - 8	3
medium gravel	8 - 11	4
medium gravel	11 - 16	5
coarse gravel	16 - 22	12
coarse gravel	22 - 32	23
very coarse gravel	32 - 45	34
very coarse gravel	45 - 64	14
small cobble	64 - 90	6
medium cobble	90 - 128	1
large cobble	128 - 180	2
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**110**
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		**110**

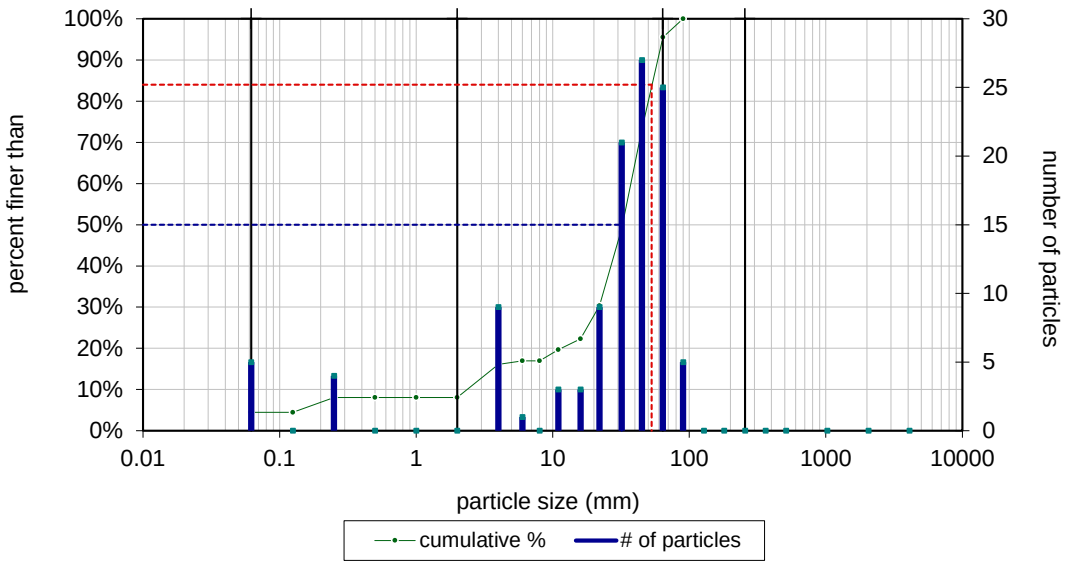


Size (mm & in)			Size Distribution		Type	
D_{16}	16	0.6	mean	28.8	silt/clay	1%
D_{35}	25	1.0	dispersion	1.8	sand	2%
D_{50}	33	1.3	skewness	-0.08	gravel	89%
D_{65}	39	1.5			cobble	8%
D_{84}	52	2.0			boulder	0%
D_{95}	78	3.1				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 18
Recorder:	CF	**Date:**	4/18/2020
Location:	CFR	**Time:**	12:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**9**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**0**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**9**
coarse gravel	22 - 32	**21**
very coarse gravel	32 - 45	**27**
very coarse gravel	45 - 64	**25**
small cobble	64 - 90	**5**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		**112**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**112**

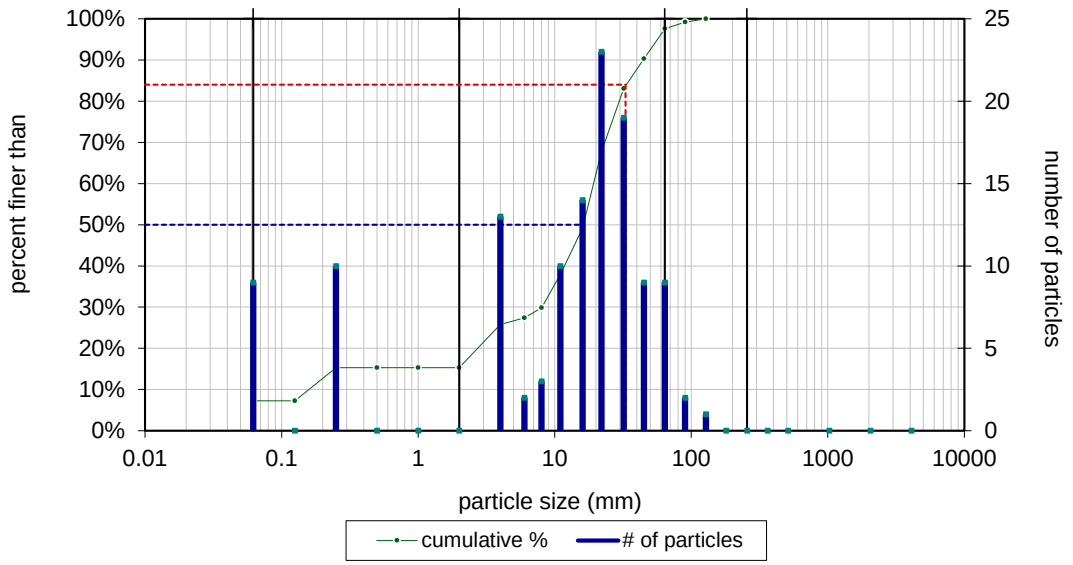


Size (mm & in)			Size Distribution		Type	
D_{16}	4	0.2	mean	14.6	silt/clay	4%
D_{35}	24	0.9	dispersion	4.8	sand	4%
D_{50}	32	1.3	skewness	-0.32	gravel	88%
D_{65}	40	1.6			cobble	4%
D_{84}	53	2.1			boulder	0%
D_{95}	63	2.5				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 6
Recorder:	CF	**Date:**	4/20/2020
Location:	CFR	**Time:**	2:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	9
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	10
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	13
fine gravel	4 - 6	2
fine gravel	6 - 8	3
medium gravel	8 - 11	10
medium gravel	11 - 16	14
coarse gravel	16 - 22	23
coarse gravel	22 - 32	19
very coarse gravel	32 - 45	9
very coarse gravel	45 - 64	9
small cobble	64 - 90	2
medium cobble	90 - 128	1
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		124
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		124

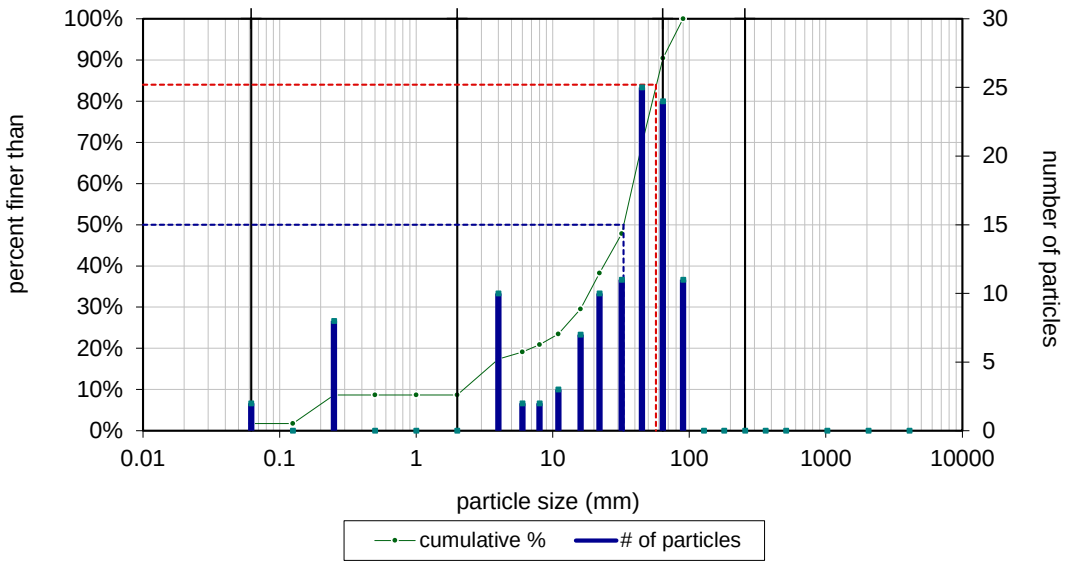


Size (mm & in)			Size Distribution		Type	
D_{16}	2.1	0.1	mean	8.3	silt/clay	7%
D_{35}	9.8	0.4	dispersion	4.8	sand	8%
D_{50}	16	0.6	skewness	-0.26	gravel	82%
D_{65}	21	0.8			cobble	2%
D_{84}	33	1.3			boulder	0%
D_{95}	56	2.2				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 21
Recorder:	CF	**Date:**	4/20/2020
Location:	CFR	**Time:**	1:50 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**8**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**11**
very coarse gravel	32 - 45	**25**
very coarse gravel	45 - 64	**24**
small cobble	64 - 90	**11**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**115**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**115**

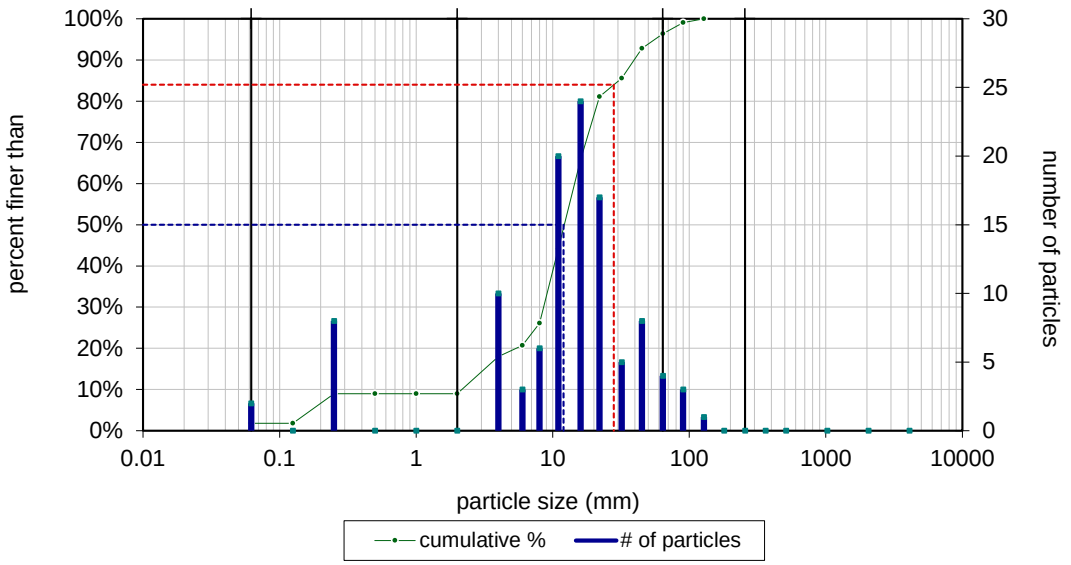


Size (mm & in)			Size Distribution		Type	
D_{16}	3.6	0.1	mean	14.3	silt/clay	2%
D_{35}	20	0.8	dispersion	5.4	sand	7%
D_{50}	33	1.3	skewness	-0.33	gravel	82%
D_{65}	42	1.7			cobble	10%
D_{84}	57	2.2			boulder	0%
D_{95}	75	3.0				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 4
Recorder:	CF	**Date:**	4/22/2020
Location:	CFR	**Time:**	9:15 AM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**8**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**20**
medium gravel	11 - 16	**24**
coarse gravel	16 - 22	**17**
coarse gravel	22 - 32	**5**
very coarse gravel	32 - 45	**8**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**3**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		**111**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**111**

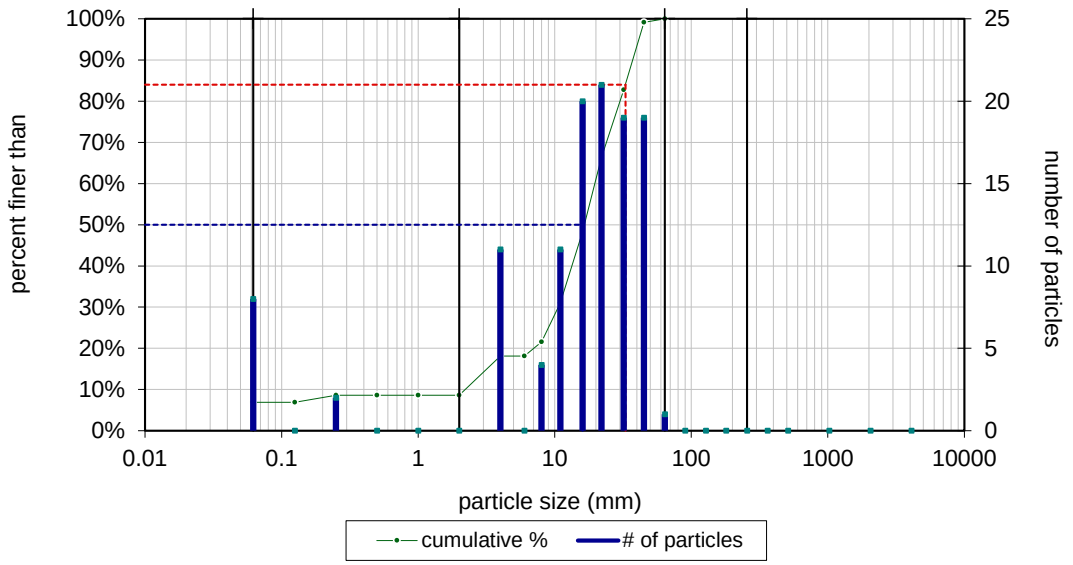


Size (mm & in)			Size Distribution		Type	
D_{16}	3.4	0.1	mean	9.8	silt/clay	2%
D_{35}	9.4	0.4	dispersion	2.9	sand	7%
D_{50}	12	0.5	skewness	-0.09	gravel	87%
D_{65}	16	0.6			cobble	4%
D_{84}	28	1.1			boulder	0%
D_{95}	56	2.2				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 1
Recorder:	CF	**Date:**	4/24/2020
Location:	CFR	**Time:**	11:00 AM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**8**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**2**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**11**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**11**
medium gravel	11 - 16	**20**
coarse gravel	16 - 22	**21**
coarse gravel	22 - 32	**19**
very coarse gravel	32 - 45	**19**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	**0**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**116**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**116**

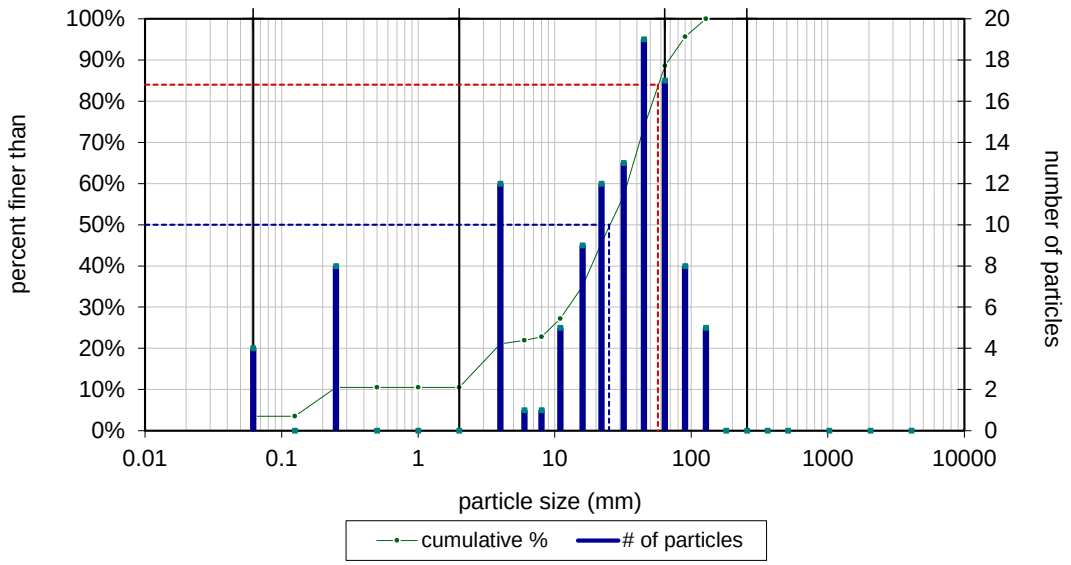


Size (mm & in)			Size Distribution		Type	
D_{16}	3.4	0.1	mean	10.6	silt/clay	7%
D_{35}	12	0.5	dispersion	3.4	sand	2%
D_{50}	16	0.6	skewness	-0.18	gravel	91%
D_{65}	21	0.8			cobble	0%
D_{84}	33	1.3			boulder	0%
D_{95}	41	1.6				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 25
Recorder:	CF	**Date:**	3/24/2020
Location:	CFR	**Time:**	

Material	Size (mm)	Count
silt/clay	0 - 0.062	**4**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**8**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**12**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**12**
coarse gravel	22 - 32	**13**
very coarse gravel	32 - 45	**19**
very coarse gravel	45 - 64	**17**
small cobble	64 - 90	**8**
medium cobble	90 - 128	**5**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		**114**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**114**

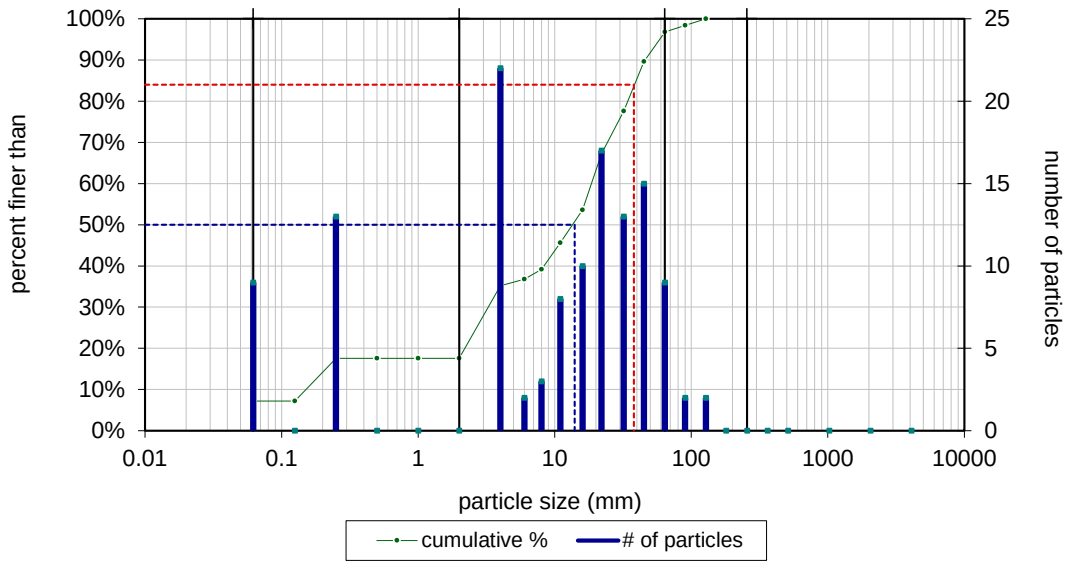


Size (mm & in)			Size Distribution		Type	
D_{16}	2.9	0.1	mean	12.9	silt/clay	4%
D_{35}	16	0.6	dispersion	5.5	sand	7%
D_{50}	25	1.0	skewness	-0.25	gravel	78%
D_{65}	38	1.5			cobble	11%
D_{84}	57	2.2			boulder	0%
D_{95}	87	3.4				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 15
Recorder:	CF	**Date:**	3/24/2020
Location:	CFR	**Time:**	3:30 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	9
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	13
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	22
fine gravel	4 - 6	2
fine gravel	6 - 8	3
medium gravel	8 - 11	8
medium gravel	11 - 16	10
coarse gravel	16 - 22	17
coarse gravel	22 - 32	13
very coarse gravel	32 - 45	15
very coarse gravel	45 - 64	9
small cobble	64 - 90	2
medium cobble	90 - 128	2
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**125**
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		**125**

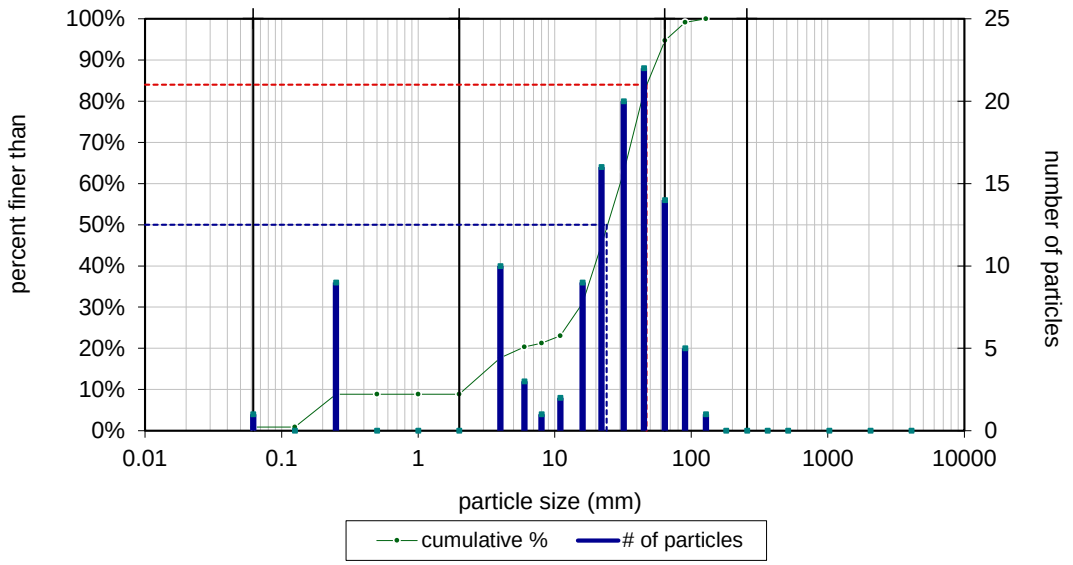


Size (mm & in)			Size Distribution		Type	
D_{16}	0.22	0.0	mean	2.9	silt/clay	7%
D_{35}	4	0.2	dispersion	33.2	sand	10%
D_{50}	14	0.6	skewness	-0.46	gravel	79%
D_{65}	21	0.8			cobble	3%
D_{84}	38	1.5			boulder	0%
D_{95}	59	2.3				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 2
Recorder:	CF	**Date:**	3/19/2020
Location:	CFR	**Time:**	4:45 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	9
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	10
fine gravel	4 - 6	3
fine gravel	6 - 8	1
medium gravel	8 - 11	2
medium gravel	11 - 16	9
coarse gravel	16 - 22	16
coarse gravel	22 - 32	20
very coarse gravel	32 - 45	22
very coarse gravel	45 - 64	14
small cobble	64 - 90	5
medium cobble	90 - 128	1
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**113**
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		**113**

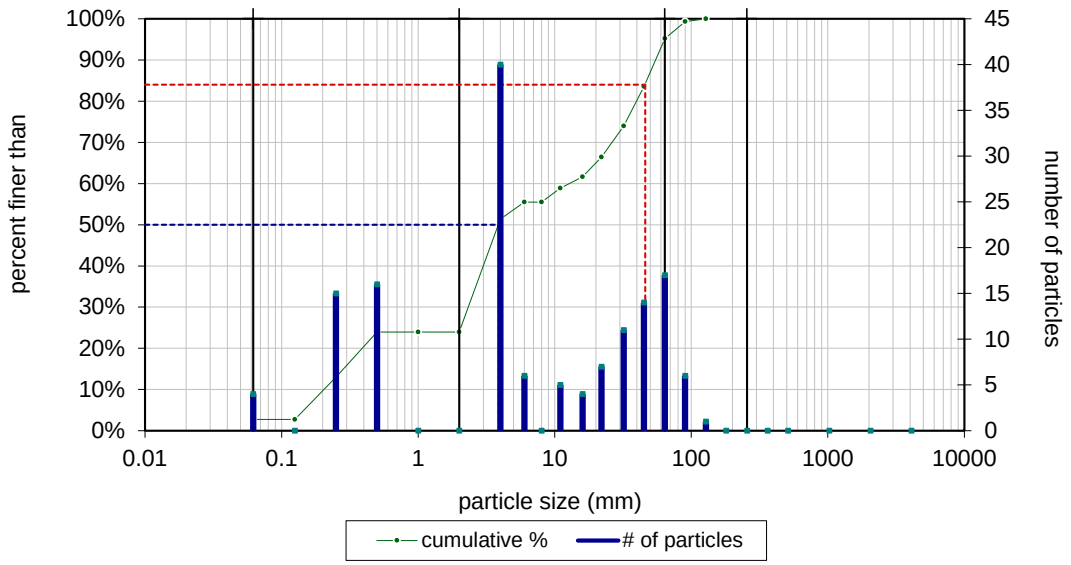


Size (mm & in)			Size Distribution		Type	
D_{16}	3.5	0.1	mean	12.8	silt/clay	1%
D_{35}	18	0.7	dispersion	4.4	sand	8%
D_{50}	24	0.9	skewness	-0.26	gravel	86%
D_{65}	33	1.3			cobble	5%
D_{84}	47	1.9			boulder	0%
D_{95}	66	2.6				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 17
Recorder:	CF	**Date:**	3/19/2020
Location:	CFR	**Time:**	4:00 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	4
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	15
medium sand	0.25 - 0.5	16
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	40
fine gravel	4 - 6	6
fine gravel	6 - 8	0
medium gravel	8 - 11	5
medium gravel	11 - 16	4
coarse gravel	16 - 22	7
coarse gravel	22 - 32	11
very coarse gravel	32 - 45	14
very coarse gravel	45 - 64	17
small cobble	64 - 90	6
medium cobble	90 - 128	1
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		**146**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
total count:		**146**

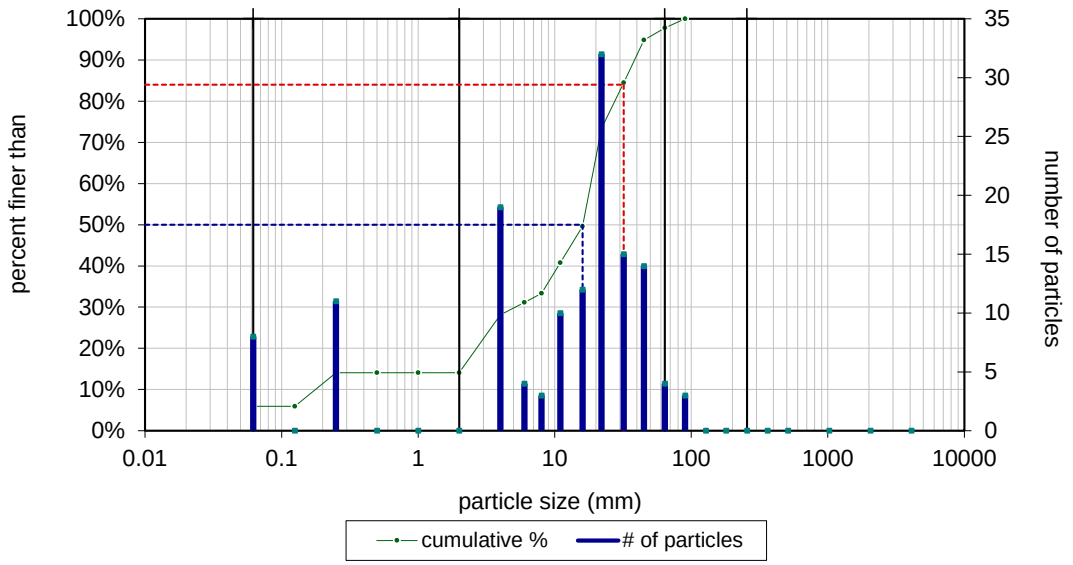


Size (mm & in)			Size Distribution		Type	
D_{16}	0.3	0.0	mean	3.7	silt/clay	3%
D_{35}	2.6	0.1	dispersion	12.4	sand	21%
D_{50}	3.9	0.2	skewness	-0.01	gravel	71%
D_{65}	20	0.8			cobble	5%
D_{84}	46	1.8			boulder	0%
D_{95}	64	2.5				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 16
Recorder:	CF	**Date:**	3/19/2020
Location:	CFR	**Time:**	3:00 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**8**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**11**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**19**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**10**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**32**
coarse gravel	22 - 32	**15**
very coarse gravel	32 - 45	**14**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**3**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**135**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**135**

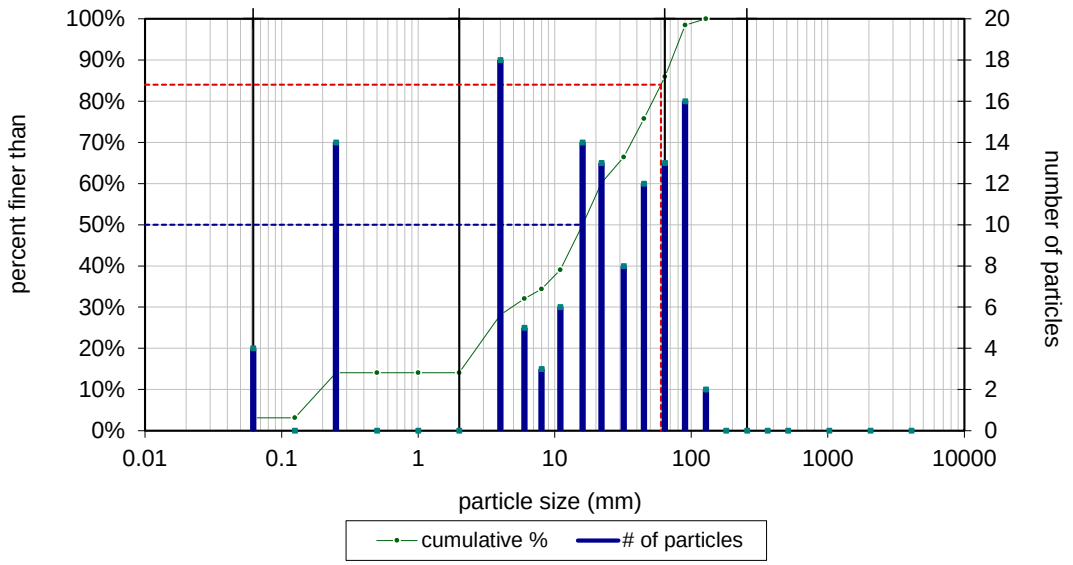


Size (mm & in)			Size Distribution		Type	
D_{16}	2.2	0.1	mean	8.4	silt/clay	6%
D_{35}	8.6	0.3	dispersion	4.6	sand	8%
D_{50}	16	0.6	skewness	-0.26	gravel	84%
D_{65}	20	0.8			cobble	2%
D_{84}	32	1.3			boulder	0%
D_{95}	46	1.8				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	TBM 24
Recorder:	CF	**Date:**	3/24/2020
Location:	CFR	**Time:**	4:00 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	4
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	14
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	18
fine gravel	4 - 6	5
fine gravel	6 - 8	3
medium gravel	8 - 11	6
medium gravel	11 - 16	14
coarse gravel	16 - 22	13
coarse gravel	22 - 32	8
very coarse gravel	32 - 45	12
very coarse gravel	45 - 64	13
small cobble	64 - 90	16
medium cobble	90 - 128	2
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		128
bedrock	0	0
clay hardpan	0	0
wood	0	0
artificial	0	0
total count:		128

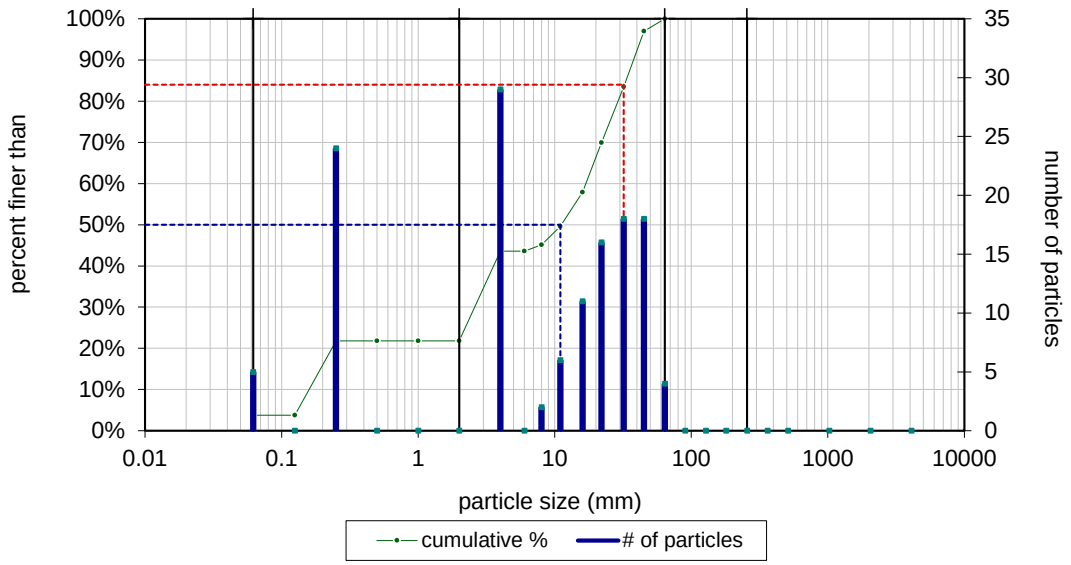


Size (mm & in)			Size Distribution		Type	
D_{16}	2.2	0.1	mean	11.5	silt/clay	3%
D_{35}	8.3	0.3	dispersion	5.5	sand	11%
D_{50}	16	0.6	skewness	-0.12	gravel	72%
D_{65}	29	1.1			cobble	14%
D_{84}	60	2.4			boulder	0%
D_{95}	82	3.2				

RDG
RIVER DESIGN GROUP

Counter:	KJ	**Section ID:**	XS 28 & 29
Recorder:	CF	**Date:**	3/23/2020
Location:	CFR	**Time:**	4:30 PM

Material	Size (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**24**
medium sand	0.25 - 0.5	**0**
coarse sand	0.5 - 1	**0**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**29**
fine gravel	4 - 6	**0**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**11**
coarse gravel	16 - 22	**16**
coarse gravel	22 - 32	**18**
very coarse gravel	32 - 45	**18**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**0**
medium cobble	90 - 128	**0**
large cobble	128 - 180	**0**
very large cobble	180 - 256	**0**
small boulder	256 - 362	**0**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
	total particle count:	**133**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**133**

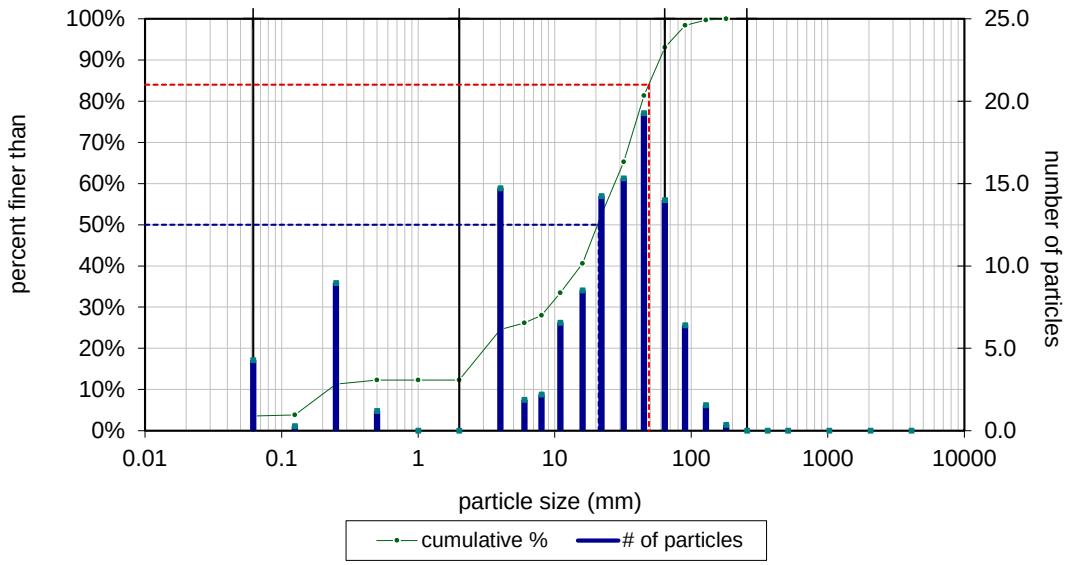


Size (mm & in)			Size Distribution		Type	
D_{16}	0.2	0.0	mean	2.5	silt/clay	4%
D_{35}	3	0.1	dispersion	29.0	sand	18%
D_{50}	11	0.4	skewness	-0.43	gravel	78%
D_{65}	19	0.7			cobble	0%
D_{84}	32	1.3			boulder	0%
D_{95}	43	1.7				

RDG
RIVER DESIGN GROUP

Counter:		**Section ID:**	**AVERAGE**
Recorder:		**Date:**	
Location:	**CFR**	**Time:**	

Material	Size (mm)	Count
silt/clay	0 - 0.062	**4.3**
very fine sand	0.062 - 0.125	**0.3**
fine sand	0.125 - 0.25	**9.0**
medium sand	0.25 - 0.5	**1.2**
coarse sand	0.5 - 1	**0.0**
very coarse sand	1 - 2	**0.0**
very fine gravel	2 - 4	**14.7**
fine gravel	4 - 6	**1.9**
fine gravel	6 - 8	**2.2**
medium gravel	8 - 11	**6.6**
medium gravel	11 - 16	**8.5**
coarse gravel	16 - 22	**14.2**
coarse gravel	22 - 32	**15.3**
very coarse gravel	32 - 45	**19.3**
very coarse gravel	45 - 64	**14.0**
small cobble	64 - 90	**6.4**
medium cobble	90 - 128	**1.6**
large cobble	128 - 180	**0.4**
very large cobble	180 - 256	**0.0**
small boulder	256 - 362	**0.0**
small boulder	362 - 512	**0.0**
medium boulder	512 - 1024	**0.0**
large boulder	1024 - 2048	**0.0**
very large boulder	2048 - 4096	**0.0**
	total particle count:	**119.76**
bedrock	0	**0**
clay hardpan	0	**0**
wood	0	**0**
artificial	0	**0**
	total count:	**119.76**



Size (mm & in)			Size Distribution		Type	
D_{16}	2.5	0.1	mean	11.1	silt/clay	4%
D_{35}	12	0.5	dispersion	5.4	sand	9%
D_{50}	21	0.8	skewness	-0.24	gravel	81%
D_{65}	32	1.3			cobble	7%
D_{84}	49	1.9			boulder	0%
D_{95}	72	2.8				

RDG
RIVER DESIGN GROUP

A-7. Stage Recorder Field Notes

Site Location	Reference Elevation (Top Cap)	Timestamp (MST) (GMT -7)	Depth from Reference to WSEL (ft)	WSEL	Serial # / Owner	Depth from Reference to Transducer (ft)	Transducer Elevation	NOTE
Barometric Control Pipe	0.000	03/03/2020 11:07	0.000	**n/a**	20788751 / RDG	0.000	0.000	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/03 @ 11:00
TBM1	4734.120	03/08/2020 14:30	5.150	**4728.970**	20788752 / RDG	5.460	4728.660	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/08 @ 14:30
TBM2	4717.090	03/04/2020 18:18	4.280	**4712.810**	20788743 / RDG	4.900	4712.190	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/04 @ 18:00
TBM3	4706.010	03/05/2020 17:17	4.670	**4701.340**	20788744 / RDG	5.470	4700.540	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/05 @ 17:00
TBM4	4682.520	03/05/2020 12:00	5.080	**4677.440**	20788742 / RDG	5.440	4677.080	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/05 @ 12:00
TBM5	4644.510	03/04/2020 11:15	3.990	**4640.520**	20788739 / RDG	4.910	4639.600	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/04 @ 17:30
TBM6	4617.080	03/05/2020 15:05	5.000	**4612.080**	20788747 / RDG	5.400	4611.680	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/05 @ 15:00
TBM7	4591.160	03/04/2020 15:10	4.260	**4586.900**	20788750 / RDG	4.990	4586.170	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/04 @ 15:00
TBM8	4557.570	03/04/2020 16:49	3.170	**4554.400**	20788749 / RDG	4.410	4553.160	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/04 @ 16:30
TBM9	4523.620	03/07/2020 17:03	4.540	**4519.080**	20788748 / RDG	5.000	4518.620	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/07 @ 17:00
TBM10	4519.410	03/06/2020 17:12	4.930	**4514.480**	20788745 / RDG	5.460	4513.950	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/06 @ 17:00
TBM11	4491.430	03/07/2020 13:30	4.940	**4486.490**	20788740 / RDG	5.470	4485.960	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/07 @ 13:30
TBM12	4455.550	03/08/2020 10:32	4.370	**4451.180**	20788741 / RDG	5.390	4450.160	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/08 @ 10:30
TBM13	4445.810	03/07/2020 10:29	5.280	**4440.530**	20788738 / RDG	6.050	4439.760	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/07 @ 10:30
TBM14	4416.000	03/06/2020 15:22	4.740	**4411.260**	20788746 / RDG	5.590	4410.410	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/06 @ 15:30
TBM15	4350.940	03/06/2020 12:46	4.810	**4346.130**	20788737 / RDG	5.580	4345.360	Delayed launch set for 2020/03/02 @ 12:00, cut data from then thru 2020/03/06 @ 12:30
Downloaded 2020/06/04								
TBM7	4591.160	06/04/2020 13:50			20788750 / RDG	4.990	4586.170	Logger was removed on 2020-06-04 @ 13:50mst because the pipe was compromised due to the high flows, and was close to being washed out. WSEL was not recorded, therefore will use the WSEL from install.
Downloaded 2020/10/13-15								
TBM13	4445.810	10/13/2020 15:37	5.280	**4440.530**	20788738 / RDG	6.000	4439.810	HOBO was covered & buried in silt. Removed HOBO from pipe.
TBM10	4519.410	10/13/2020 16:45	4.900	**4514.510**	20788745 / RDG	5.470	4513.940	HOBO was covered & buried in silt. Sediment aggraded 0.97' since install, will have to adjust during next install. Removed HOBO from pipe.
TBM9	4523.620	10/13/2020 17:55	4.540	**4519.080**	20788748 / RDG	5.000	4518.620	Sediment aggraded 0.32' since install, adjust during next install. Removed HOBO from pipe.
TBM1	4734.120	10/14/2020 09:34	5.180	**4728.940**	20788752 / RDG	5.470	4728.650	Sediment aggraded 0.40' since install, adjust during next install. Removed HOBO from pipe.
TBM2	4717.090	10/14/2020 10:48	4.340	**4712.750**	20788743 / RDG	4.900	4712.190	Sediment aggraded 0.09' since install. Removed HOBO from pipe.
TBM3	4706.010	10/14/2020 12:00	4.570	**4701.440**	20788744 / RDG	5.440	4700.570	Sediment aggraded 0.48' since install, adjust during next install. Removed HOBO from pipe.
TBM4	4682.520	10/14/2020 13:05	4.780	**4677.740**	20788742 / RDG	5.450	4677.070	Sediment aggraded 0.07' since install. Removed HOBO from pipe.
TBM5	4644.510	10/14/2020 14:10	3.840	**4640.670**	20788739 / RDG	4.920	4639.590	Sediment aggraded 0.32' since install, adjust during next install. Removed HOBO from pipe.
TBM6	4617.080	10/14/2020 16:08	4.830	**4612.250**	20788747 / RDG	5.400	4611.680	Sediment aggraded 0.37' since install, adjust during next install. Removed HOBO from pipe.
TBM8	4557.570	10/15/2020 09:37	2.920	**4554.650**	20788749 / RDG	4.410	4553.160	Sediment aggraded 0.33' since install, adjust during next install. Removed HOBO from pipe.
TBM11	4491.430	10/15/2020 11:15	4.820	**4486.610**	20788740 / RDG	5.480	4485.950	Sediment aggraded 0.81' since install, adjust during next install. Removed HOBO from pipe. **Consider moving logger b/c if it gets raised by 1.0' then it will be out of water at base flow.**
TBM12	4455.550	10/15/2020 12:43	4.340	**4451.210**	20788741 / RDG	5.370	4450.180	Sediment aggraded 0.46' since install, adjust during next install. Removed HOBO from pipe.
TBM14	4416.000	10/15/2020 13:47	4.620	**4411.380**	20788746 / RDG	5.560	4410.440	Sediment aggraded 0.41' since install, adjust during next install. Removed HOBO from pipe.
TBM15	4350.940	10/15/2020 15:07	4.690	**4346.250**	20788737 / RDG	5.560	4345.380	Sediment aggraded 0.87' since install, will have to adjust during next install. Removed HOBO from pipe. Debris line was 2.1' from top of HOBO pipe.
Barometric Control Pipe	0.000	10/15/2020 16:15	n/a	**n/a**	20788751 / RDG	n/a	n/a	

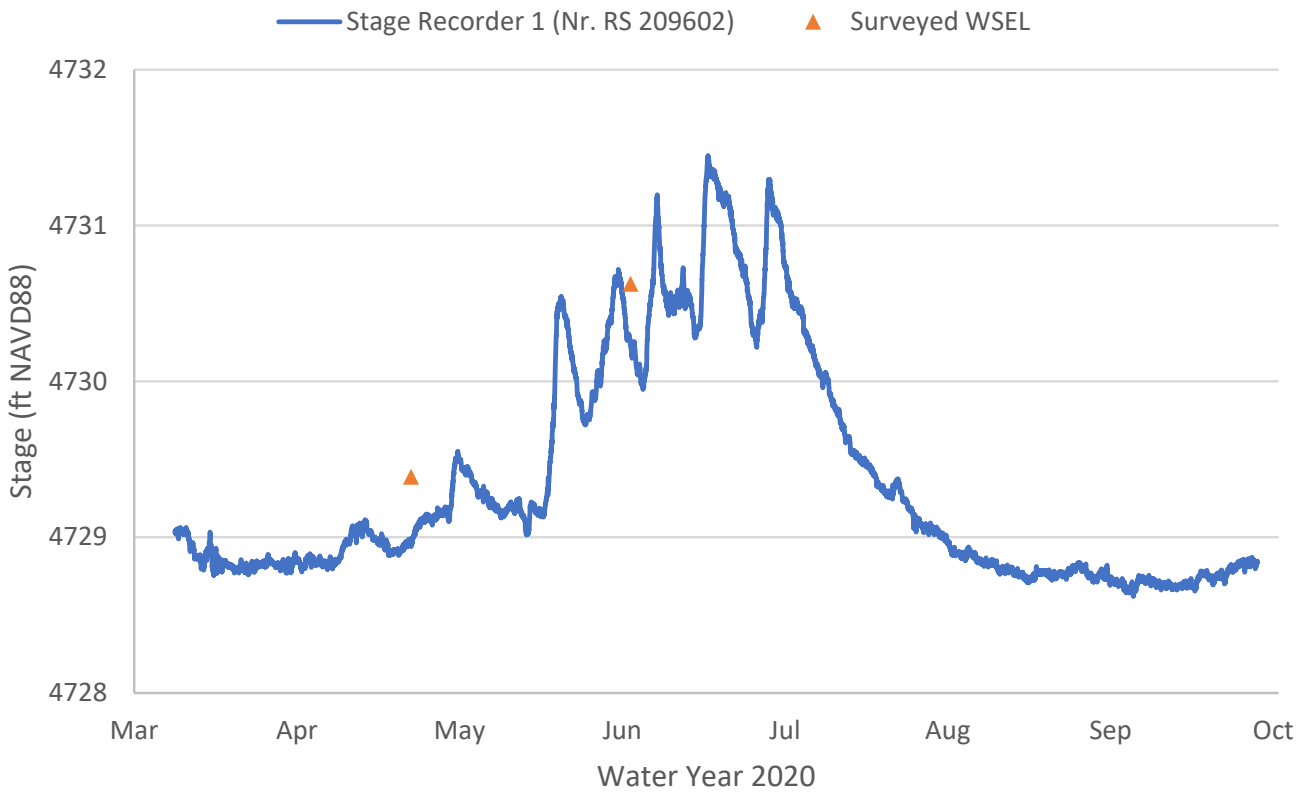
A-8. Crest Stage Gage Field Notes.

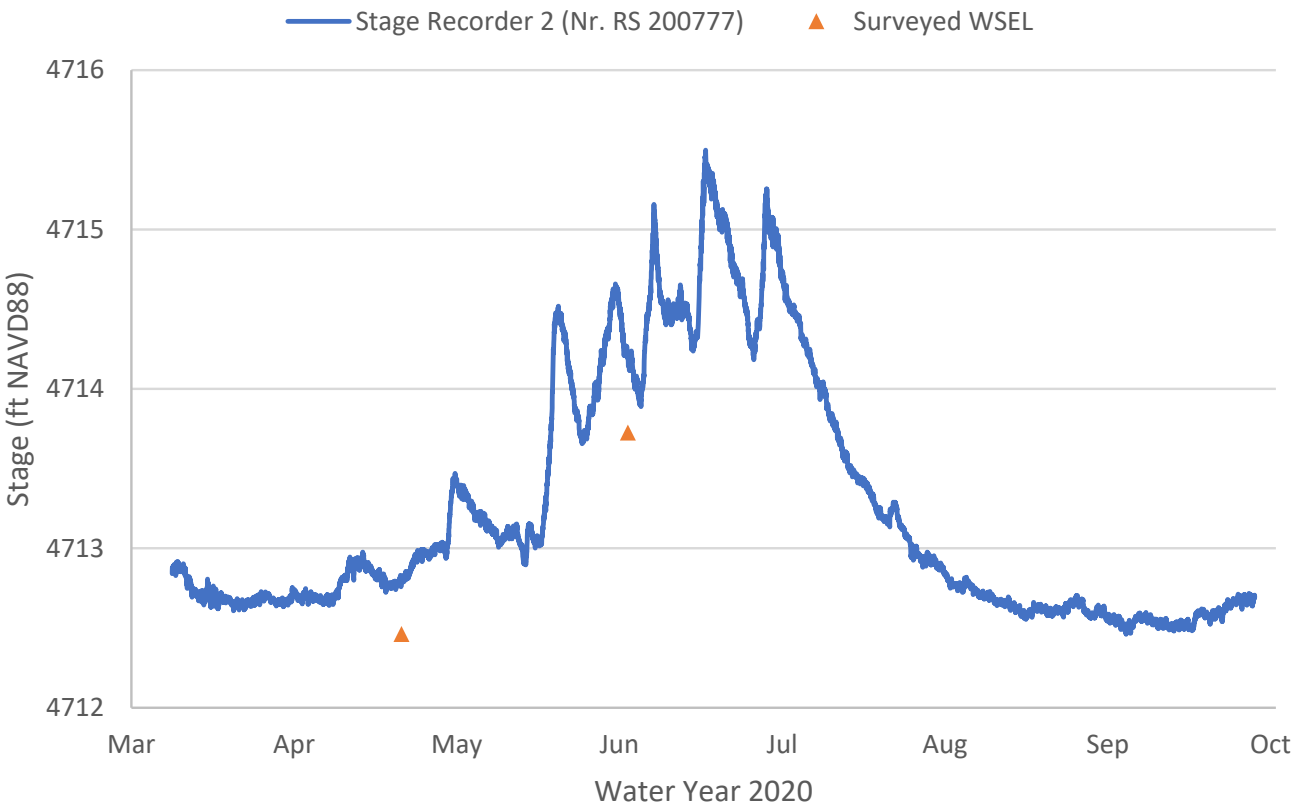
Site Location	Reference Elevation at Top Bolt (ft NAVD88)	Timestamp (MST) (GMT -7)	Cork Measurement (ft)	Measured WSEL (ft NAVD88)	Notes
TBM13	4442.95	10/13/2020 15:37	1.21	4444.16	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4442.95	10/13/2020 15:37	1.12	4444.07	2nd measurment
	4442.95	10/13/2020 15:37	0.99	4443.94	3rd measurment
TBM10	4515.61	10/13/2020 17:06	1.89	4517.50	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4515.61	10/13/2020 17:06	1.82	4517.43	2nd measurment
	4515.61	10/13/2020 17:06	1.65	4517.26	3rd measurment
TBM9	4520.11	10/13/2020 17:47	2.20	4522.31	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4520.11	10/13/2020 17:47	2.09	4522.20	2nd measurment
	4520.11	10/13/2020 17:47	1.85	4521.96	3rd measurment
TBM1	4729.99	10/14/2020 9:25	1.87	4731.86	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4729.99	10/14/2020 9:25	1.67	4731.66	2nd measurment
	4729.99	10/14/2020 9:25	1.47	4731.46	3rd measurment
	4729.99	10/14/2020 9:25	1.37	4731.36	4th measurment
TBM2	4713.49	10/14/2020 10:40	2.44	4715.93	The cork line was not conclusive as there was no obvious line. I chose highest cork mark which coincided with water mark stain. Cleaned both pipes, and re-set with new cork in bottom.
	4713.49	10/14/2020 10:40	2.23	4715.72	2nd measurment
TBM3	4702.75	10/14/2020 11:50	1.55	4704.30	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4702.75	10/14/2020 11:50	1.45	4704.20	2nd measurment
TBM4	4678.71	10/14/2020 12:55	1.60	4680.31	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4678.71	10/14/2020 12:55	1.46	4680.17	2nd measurment
TBM5	4641.42	10/14/2020 14:27	1.73	4643.15	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4641.42	10/14/2020 14:27	1.61	4643.03	2nd measurment
TBM6	4612.79	10/14/2020 16:26	1.85	4614.64	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4612.79	10/14/2020 16:26	1.28	4614.07	2nd measurment….cork is present within the 1st and 2nd measurement, and probably past 1.28, but it was not noted in the field.
TBM7	4588.17	10/15/2020 8:55	2.50	4590.67	The cork line was not conclusive as there was no obvious line. There was no water mark stain, or obvious cork line. Cleaned both pipes, and re-set with new cork in bottom.
TBM8	4555.79	10/15/2020 9:56	1.78	4557.57	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4555.79	10/15/2020 9:56	1.69	4557.48	2nd measurment
	4555.79	10/15/2020 9:56	1.49	4557.28	3rd measurment
	4555.79	10/15/2020 9:56	1.34	4557.13	4th measurment
TBM11	4488.33	10/15/2020 11:00	1.42	4489.75	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4488.33	10/15/2020 11:00	1.31	4489.64	2nd measurment
	4488.33	10/15/2020 11:00	1.21	4489.54	3rd measurment
TBM12	4452.01	10/15/2020 12:32	2.54	4454.55	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4452.01	10/15/2020 12:32	2.32	4454.33	2nd measurment
TBM14	4412.04	10/15/2020 14:00	2.66	4414.70	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4412.04	10/15/2020 14:00	2.58	4414.62	2nd measurment
	4412.04	10/15/2020 14:00	2.13	4414.17	3rd measurment
TBM15	4347.79	10/15/2020 15:30	2.04	4349.83	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.

A-8. Crest Stage Gage Field Notes.

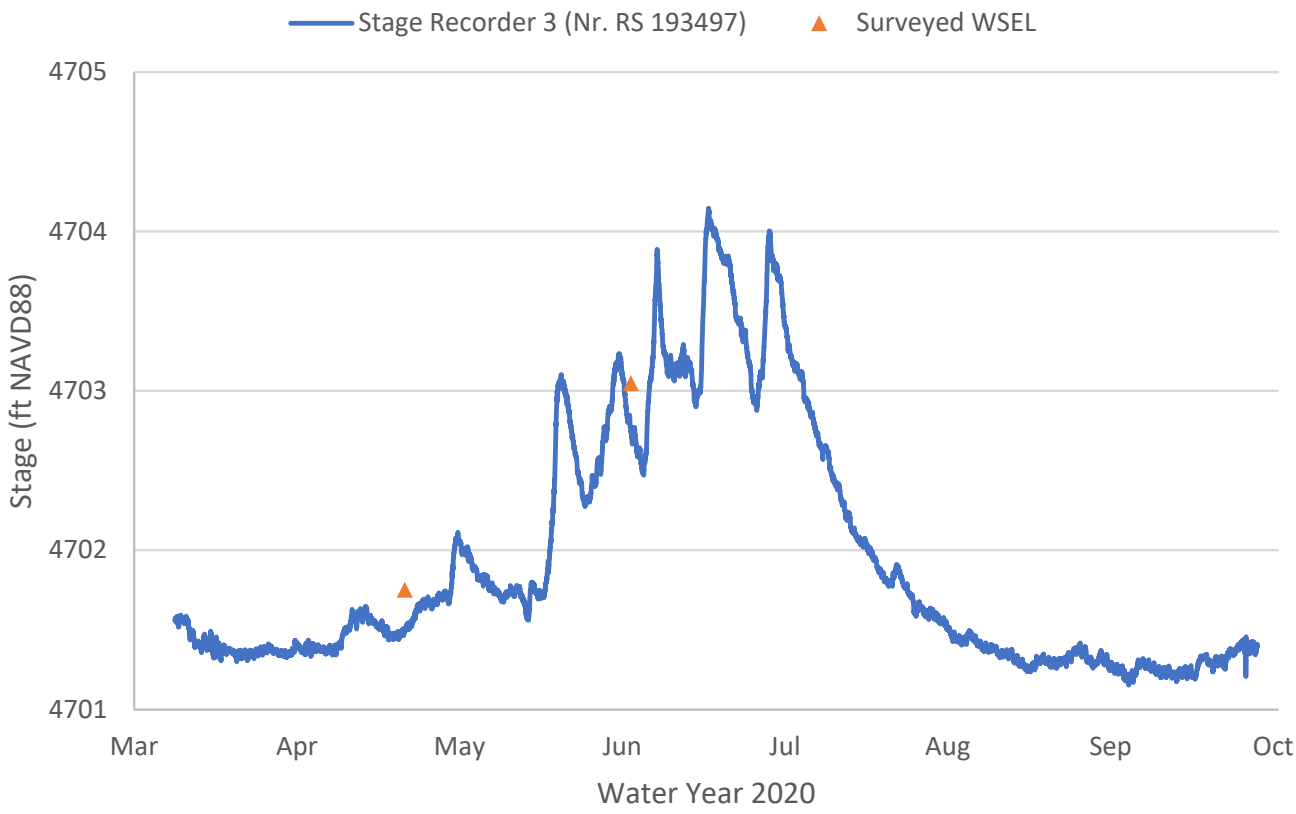
Site Location	Reference Elevation at Top Bolt (ft NAVD88)	Timestamp (MST) (GMT -7)	Cork Measurement (ft)	Measured WSEL (ft NAVD88)	Notes
	4347.79	10/15/2020 15:30	1.71	4349.50	2nd measurment
TBM18	4660.22	11/3/2020 11:26	0.99	4661.21	Pipe is out of water 0.15'. This flow is as high as it can get in order to access cork. Could access logger by walking from NE Conrer of Racetrak Pond. Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4660.22	11/3/2020 11:26	0.90	4661.12	2nd measurment
TBM19	4651.4	11/3/2020 12:15	0.88	4652.28	Possibility of access to this site from upstream river right landowner. Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4651.4	11/3/2020 12:15	0.75	4652.15	2nd measurment
TBM20	4647.24	11/3/2020 12:45	1.11	4648.35	Pipe is out of water 0.10'. This flow is as high as it can get in order to access cork. Possible access to site thru landowners on river right. Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4647.24	11/3/2020 12:45	1.02	4648.26	2nd measurment
	4647.24	11/3/2020 12:45	0.39	4647.63	3rd measurment
	4647.24	11/3/2020 12:45	0.30	4647.54	4th measurment
	4647.24	11/3/2020 12:45	0.24	4647.48	5th measurement
TBM21	4619.28	11/3/2020 15:00	0.89	4620.17	Pipe is out of water 0.11'. This flow is as high as it can get in order to access cork. Possible access to site thru Walen / Jeremy Nicholson property on river left. Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4619.28	11/3/2020 15:00	0.80	4620.08	2nd measurment
TBM17	4737.29	11/3/2020 16:55	1.85	4739.14	Bottom of pipe was approximately 0.10' in water but was able to put frest cork in. Would be ideal if flows were 0.20' lower. Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4737.29	11/3/2020 16:55	1.73	4739.02	2nd measurment
TBM16	4747.81	11/3/2020 17:22	2.03	4749.84	Measured cork line, cleaned both pipes, and re-set with new cork in bottom.
	4747.81	11/3/2020 17:22	1.84	4749.65	2nd measurment
TBM22	4393.23	11/4/2020 11:00		4393.23	***Pipe was not found, appears to of washer out***
TBM23	4386.62	11/4/2020 11:20	2.16	4388.78	Approximately 2' of deposition built up around pipe. Bottom of cap is touching water, and would be ideal if flows were 0.20' lower for reading and re-installing.
	4386.62	11/4/2020 11:20	1.78	4388.40	2nd measurment
TBM24	4366.99	11/4/2020 13:00	2.87	4369.86	There wasn't a distinct cork line on outside of inner pipe. Rwad inside cork line of the inner pipe. This also correlates w/ water stain. Bottom of cap is approx. 0.05' from water surface.
TBM25	4353.13	11/4/2020 15:16	1.52	4354.65	Approx. 1.60' of deposition built up around pipe. T-Post is a liitle loose, might want to drive down a bit the next time out.
	4353.13	11/4/2020 15:16	1.32	4354.45	2nd measurment

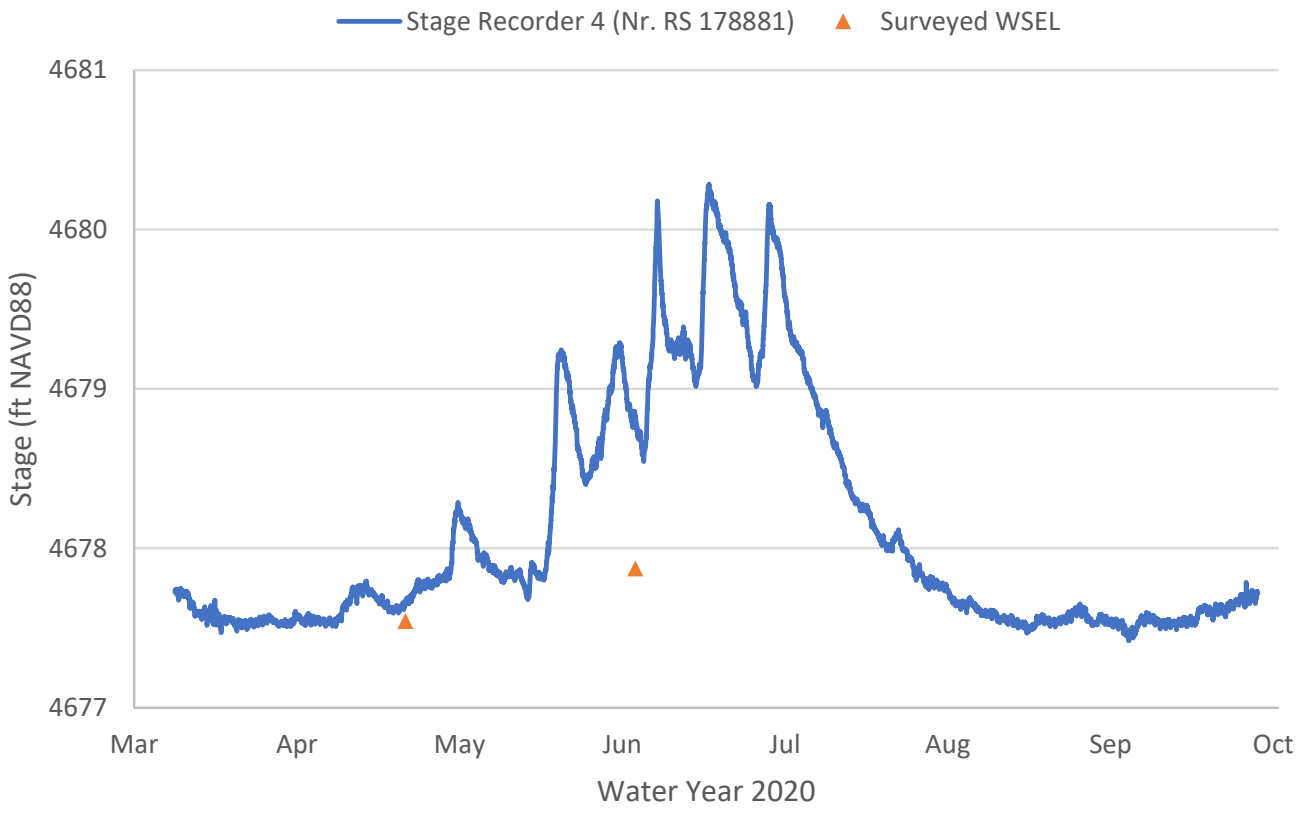
A-9. Stage recorder plots.



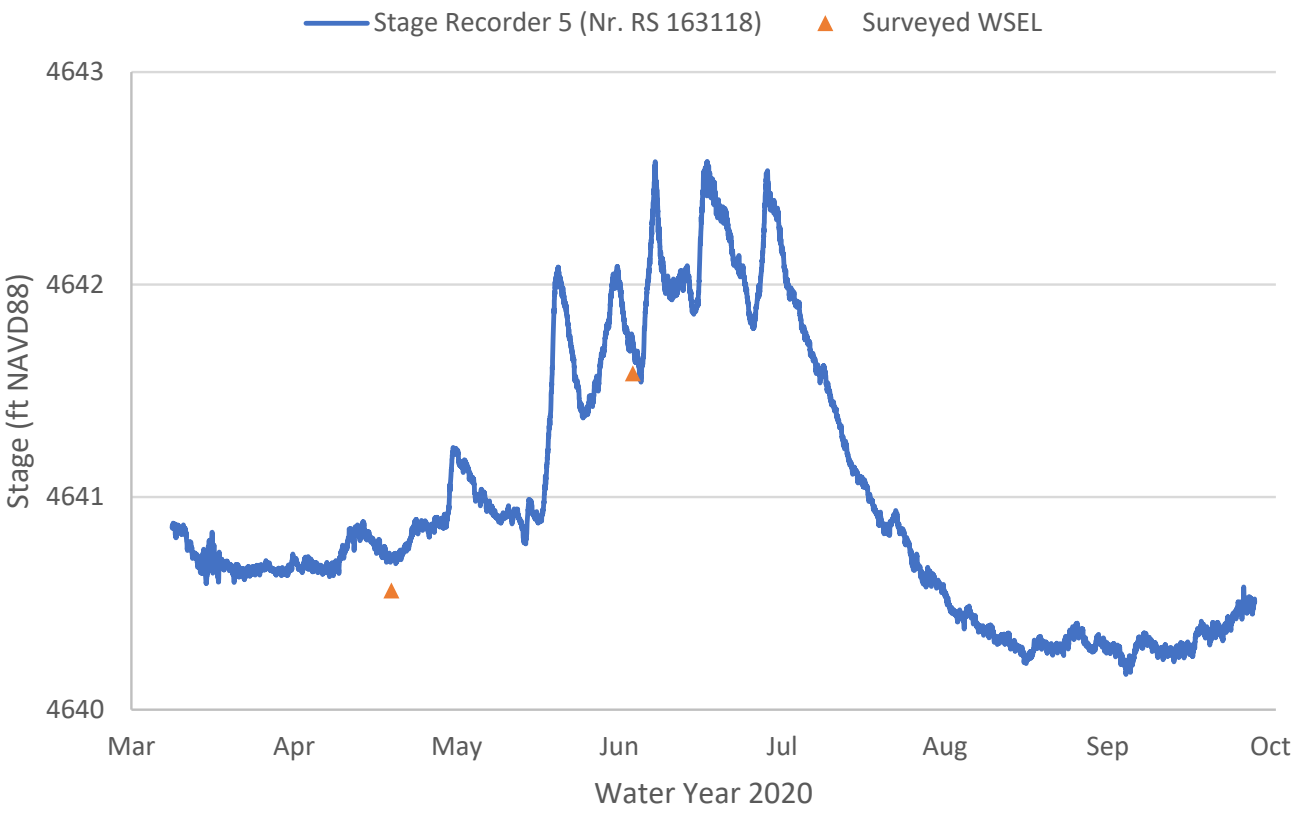


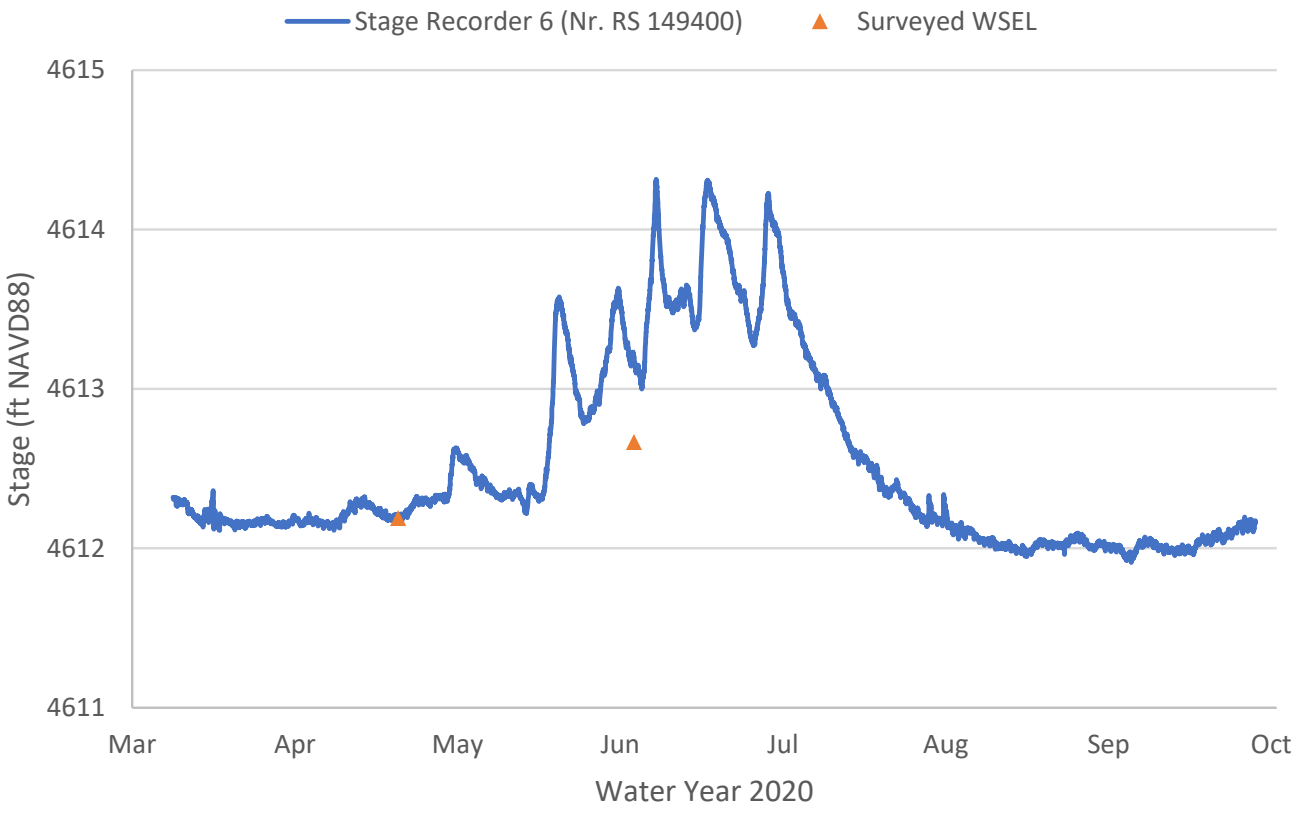
A-9. Stage recorder plots.





A-9. Stage recorder plots.





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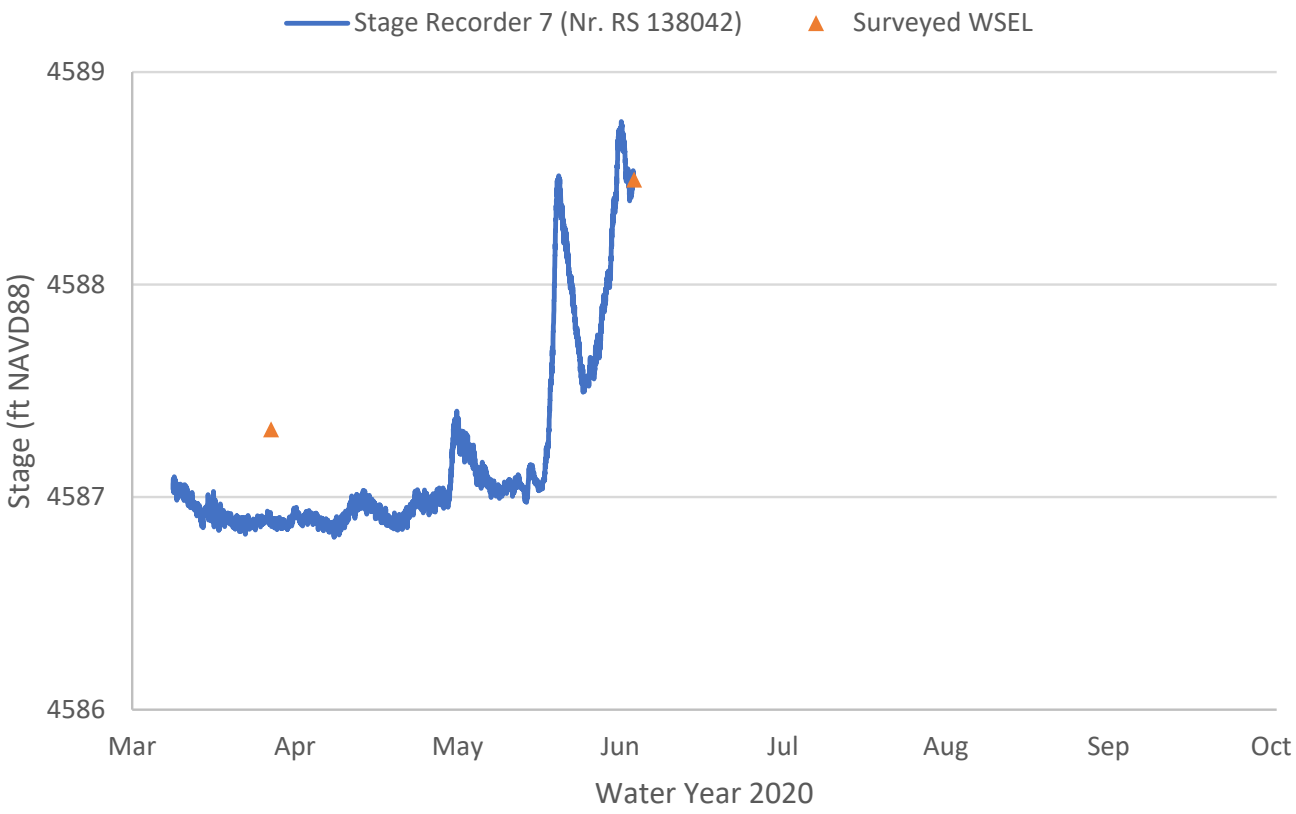
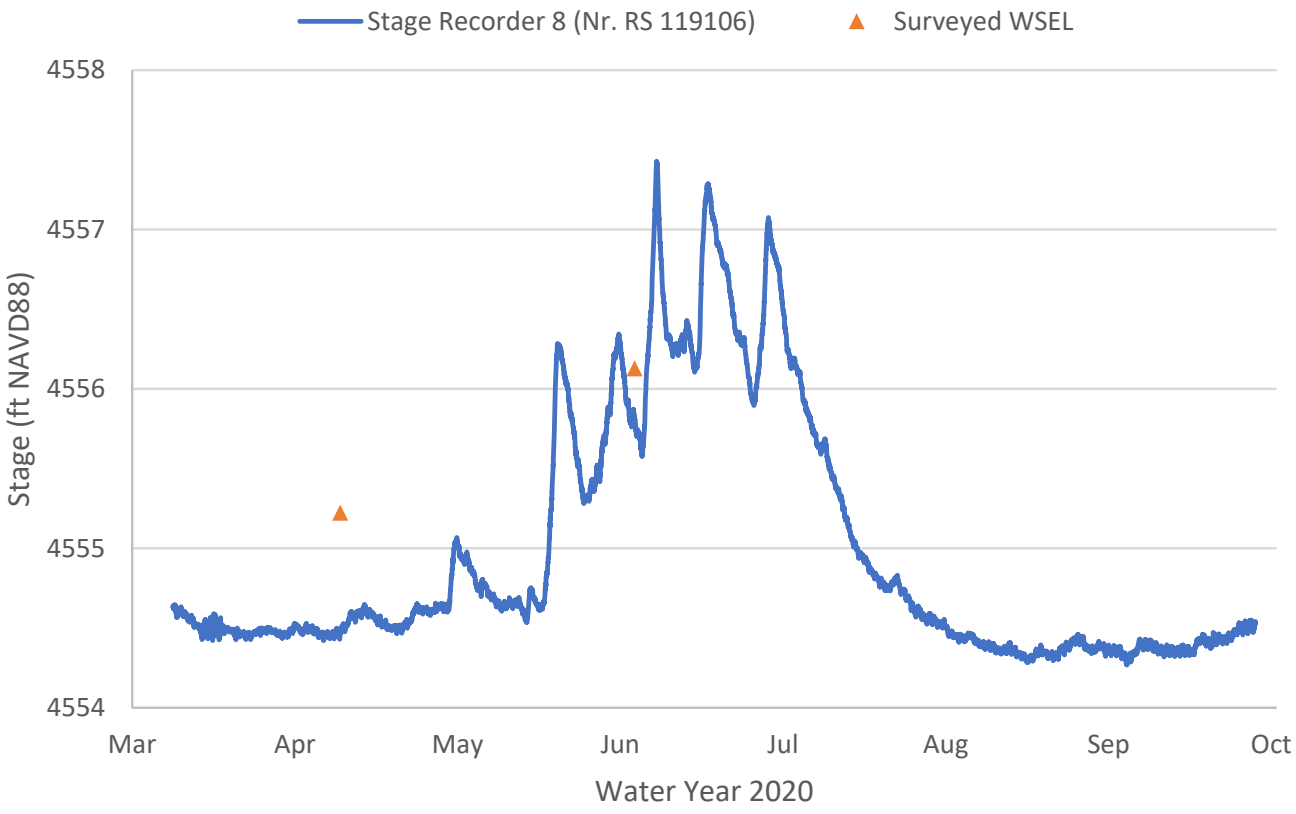
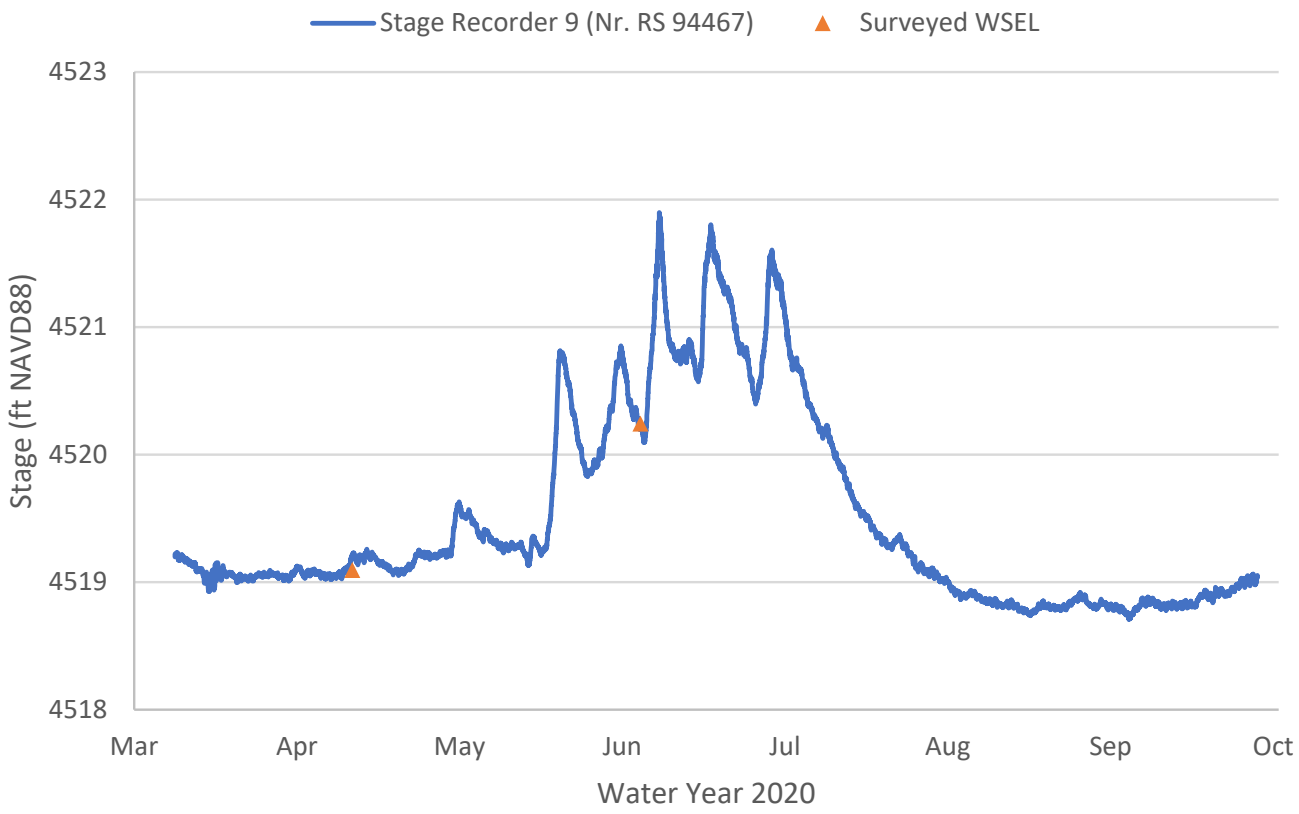




A-9. Stage recorder plots.



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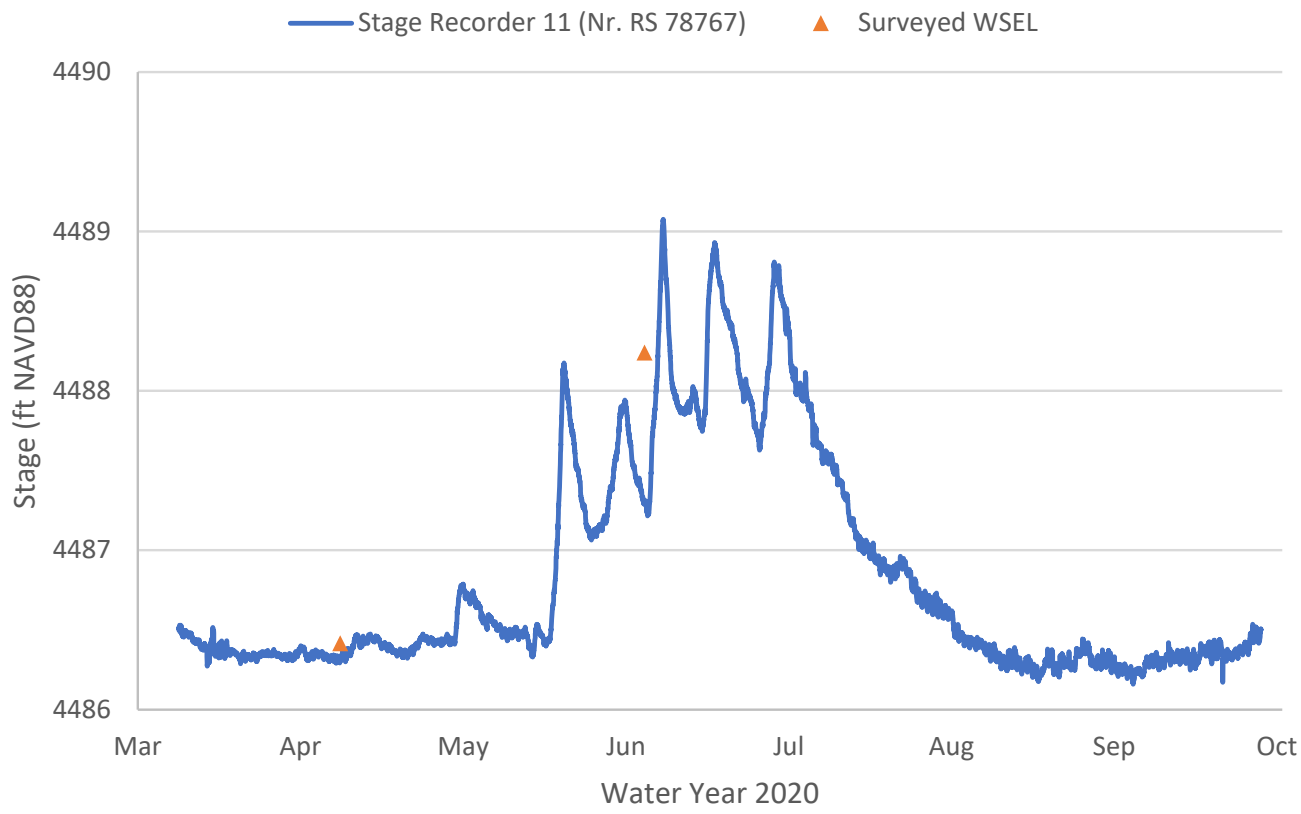
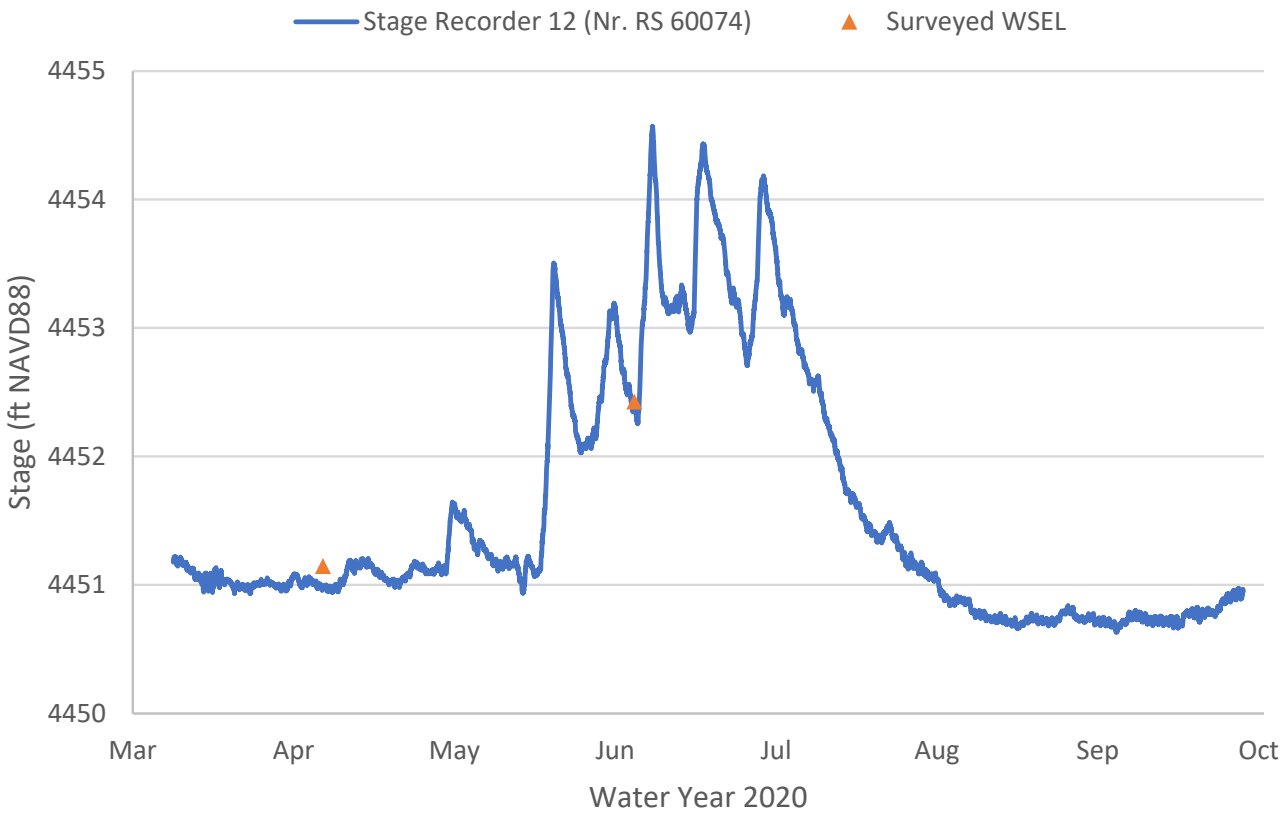
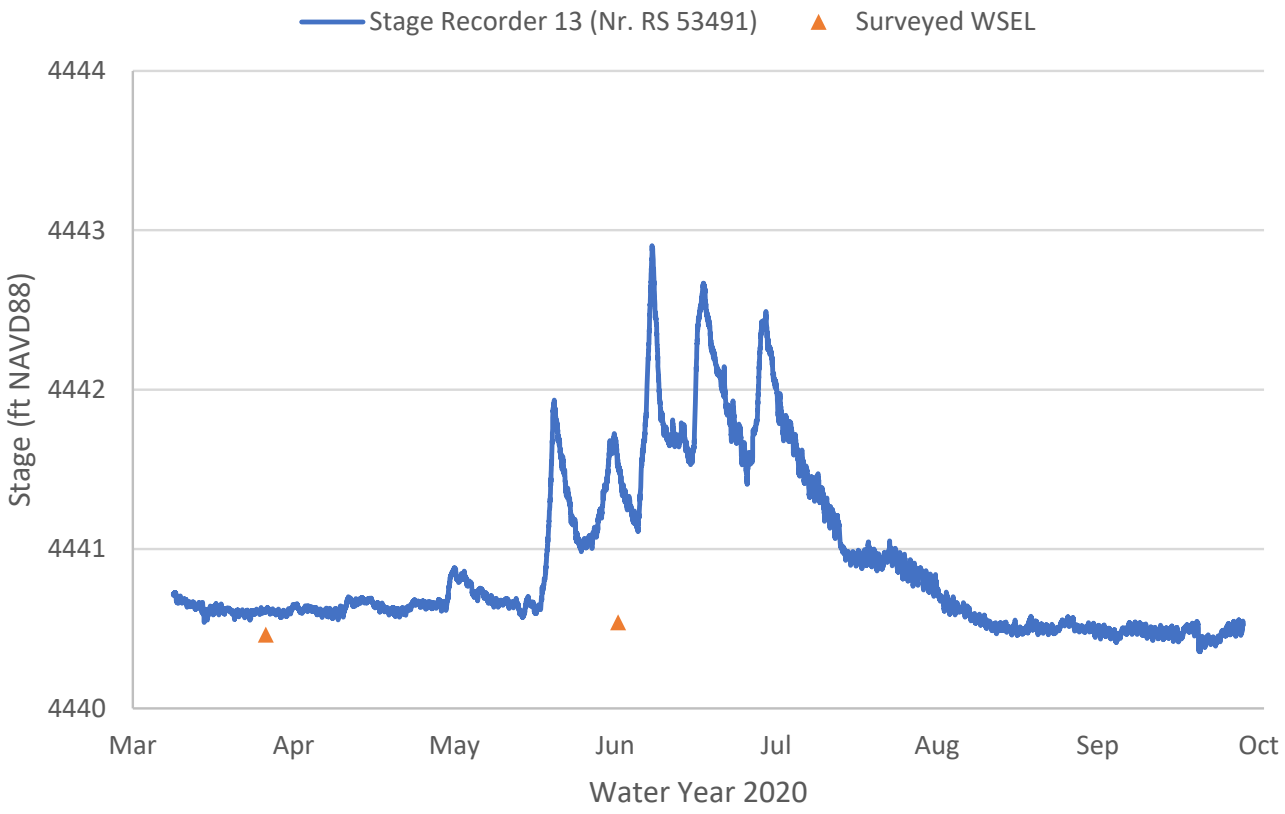
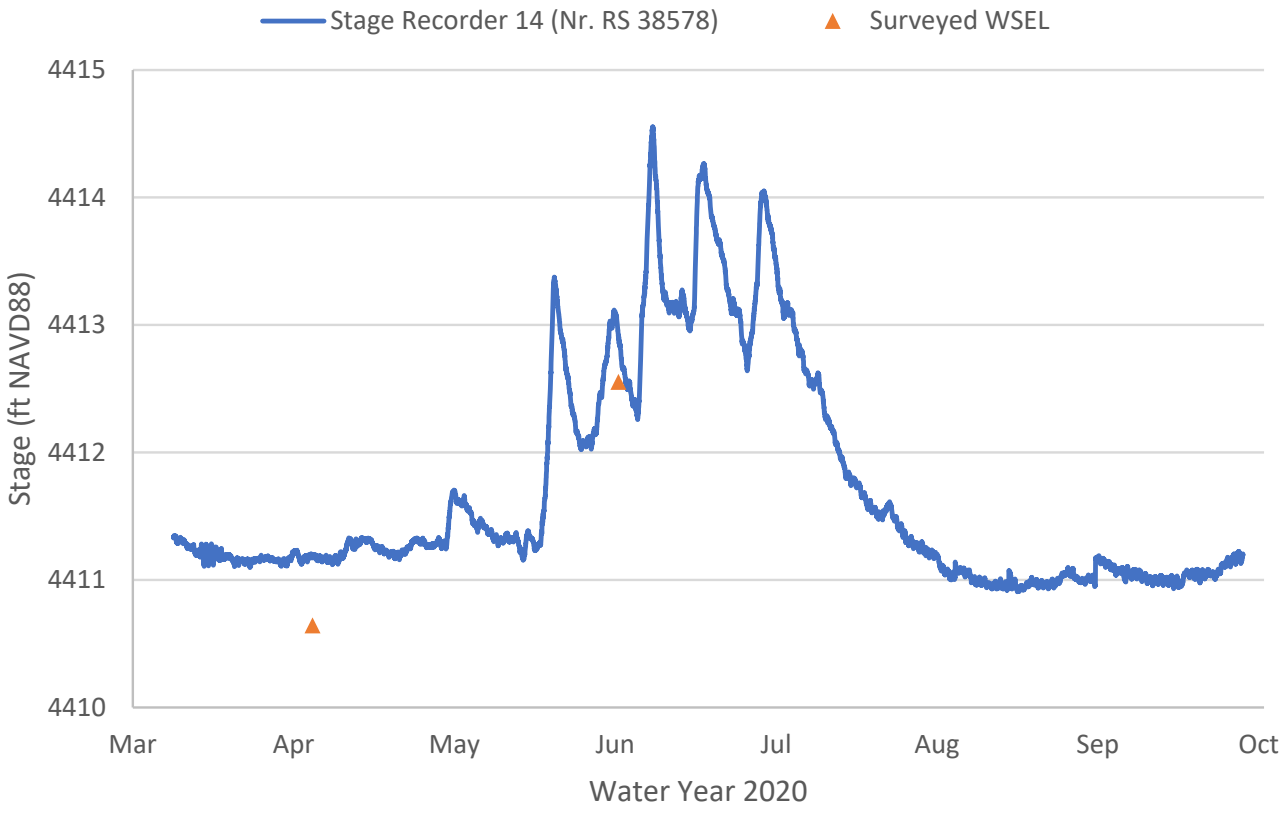


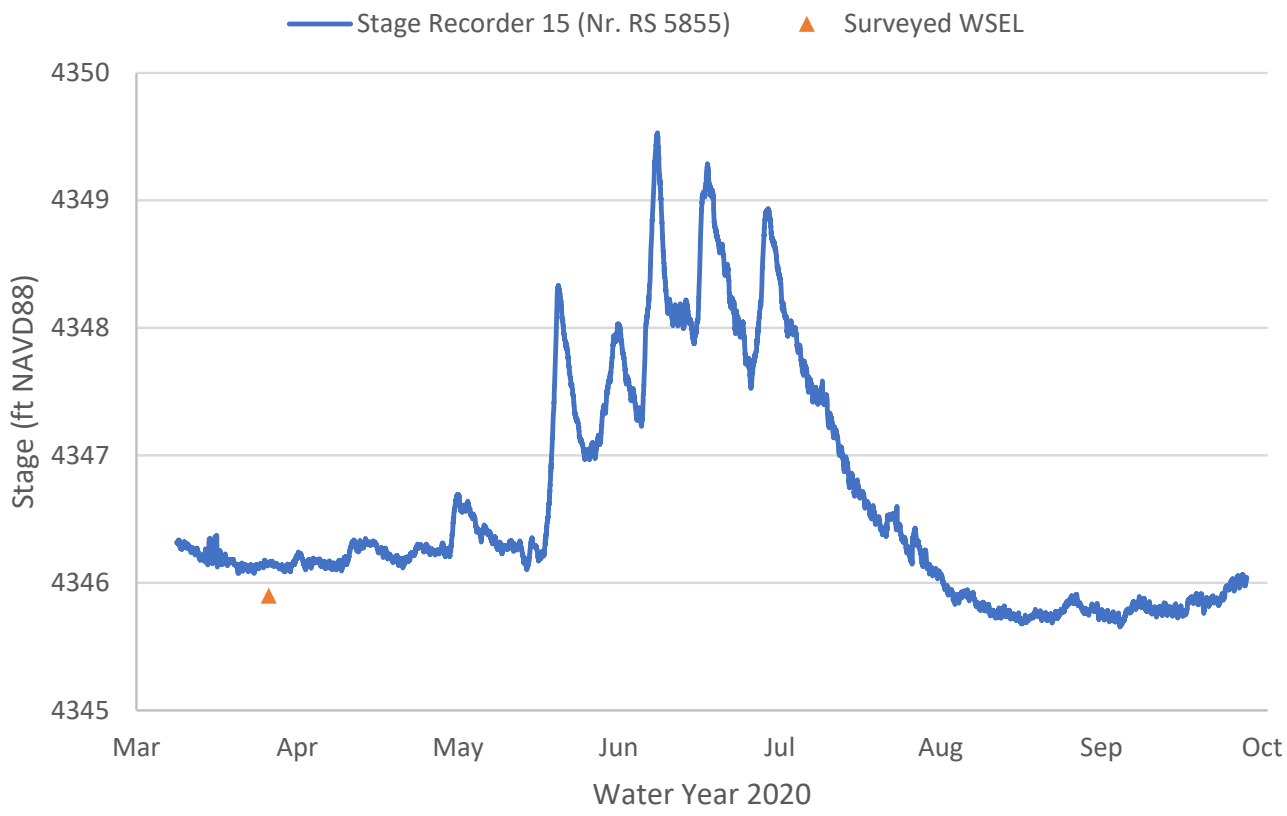


A-9. Stage recorder plots.





A-9. Stage recorder plots.



APPENDIX B – HYDROLOGIC ANALYSIS

Table B 1. Peak flow estimates for CFR Reach A at tributary junctions (cfs).

Location and Drainage Area (square miles)		Bkf.[b]	AEP-percent peak flow (QAEP)													
			99.5	99	95	90	80	66.7	50	42.9	20	10	4	2	1	0.5	0.2
			Return interval (years)														
		1.68	1.005	1.01	1.05	1.11	1.25	1.50	2.00	2.33	5	10	25	50	100	200	500
Warm Springs Creek at Warm Springs (# 12323770)	160	214	39	50	90	119	164	193	255	285	419	531	673	778	880	982	1,110
Silver Bow Creek ds Warm Springs Ponds	476	363	80	100	175	230	314	322	432	488	747	979	1,287	1,527	1,778	2,038	2,388
Clark Fork River ds Warm Springs Cr. abv Perkins Gulch	636	544	110	134	225	292	393	495	648	722	1,059	1,334	1,698	1,965	2,225	2,495	2,836
Clark Fork near Galen (# 12323800)	656	569	114	139	232	299	403	519	677	753	1,100	1,380	1,750	2,020	2,280	2,550	2,890
Clark Fork River ds Sand Creek	664	574	116	141	234	302	407	524	683	760	1,111	1,396	1,772	2,048	2,315	2,592	2,942
Clark Fork River ds Lost Creek	725	615	128	154	253	325	436	560	732	815	1,200	1,523	1,955	2,281	2,602	2,937	3,376
Clark Fork River ds Dry Cottonwood Creek	751	632	133	160	261	334	448	576	752	838	1,238	1,577	2,033	2,381	2,726	3,088	3,567
Clark Fork River ds Modesty Creek	777	649	138	165	268	344	460	591	772	860	1,275	1,629	2,109	2,479	2,850	3,238	3,758
Clark Fork River ds Sand Hollow	788	655	140	168	271	348	465	597	780	870	1,290	1,652	2,141	2,521	2,902	3,301	3,839
Clark Fork River ds Racetrack Creek	839	689	150	179	287	366	488	627	820	914	1,364	1,758	2,297	2,722	3,155	3,610	4,237
Clark Fork River ds Orofino Creek	862	703	154	184	294	374	499	640	837	934	1,396	1,805	2,366	2,812	3,269	3,750	4,417
Clark Fork River ds Caribou-Dempsey Creek	899	727	162	192	305	387	515	661	865	965	1,448	1,881	2,479	2,960	3,456	3,980	4,716
Clark Fork River ds Powell Creek	939	751	170	201	316	401	533	683	894	998	1,503	1,962	2,599	3,118	3,657	4,228	5,041
Clark Fork River ds Peterson Creek	978	775	178	209	328	415	550	704	923	1,031	1,558	2,042	2,718	3,275	3,858	4,478	5,369
Clark Fork River ds Tin Cup Joe Creek	1,001	790	182	215	334	423	560	717	940	1,050	1,590	2,090	2,790	3,370	3,980	4,630	5,569
Clark Fork at Deer Lodge (# 12324200)	1,001	790	182	215	335	423	560	717	940	1,050	1,590	2,090	2,790	3,370	3,980	4,630	5,570
Clark Fork River ds Taylor Creek	1,011	809	186	219	343	434	575	734	964	1,076	1,625	2,130	2,832	3,408	4,010	4,648	5,564
Clark Fork River ds Cottonwood Creek	1,055	901	201	239	381	485	644	814	1,072	1,194	1,788	2,315	3,018	3,576	4,142	4,729	5,539
Clark Fork River ds Spring Gulch	1,070	931	206	246	394	502	667	840	1,108	1,234	1,842	2,375	3,079	3,630	4,184	4,755	5,532
Clark Fork River ds Fred Burr Creek	1,073	937	207	248	396	505	672	846	1,116	1,242	1,853	2,388	3,091	3,641	4,192	4,760	5,530
Clark Fork River ds Mullan Gulch	1,089	973	213	255	411	525	699	876	1,158	1,288	1,915	2,457	3,161	3,702	4,240	4,788	5,521
Clark Fork River ds ONeill Creek	1,121	1,046	225	271	442	566	755	940	1,245	1,383	2,044	2,600	3,301	3,826	4,334	4,845	5,505
Clark Fork abv Little Blackfoot R. nr Garrison (# 12324400)	1,130	1,067	229	276	451	578	771	958	1,270	1,410	2,080	2,640	3,340	3,860	4,360	4,860	5,500
Clark Fork River ds Little Blackfoot River	1,559	1,841	417	536	992	1,321	1,801	2,066	2,192	2,461	3,753	4,886	6,391	7,555	8,759	9,962	11,565
Clark Fork at Goldcreek (# 12324680)	1,774	2,293	531	700	1,364	1,844	2,535	2,020	2,730	3,080	4,760	6,260	8,300	9,900	11,600	13,300	15,600

[a] Flows interpolated using logarithms of drainage area (Sando etal. 2018a).

[b] Bankfull estimated using 0.84 * Q2 (Lawlor 2004).

Blue highlighted lines are USGS gages.

Table B-2. Flow duration estimates at analysis points (cfs).

Location and Drainage Area (sq. mi.)		Percent of Time Exceeded																						
		0.1%	0.2%	0.5%	1%	2%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	85%	90%	95%	98%	99%	99.5%	99.8%	99.9%
Warm Springs Creek at Warm Springs (# 12323770)	160	464	426	386	344	287	189	120	90	75	60	50	43	36	30	24	19	15	6	3	1	1	0	0
Silver Bow Creek ds Warm Springs Ponds	473	916	772	680	588	472	311	217	170	139	105	82	70	62	53	44	39	34	28	23	21	19	17	16
Clark Fork River ds Warm Springs Cr. abv Perkins Gulch	476	921	778	685	592	475	313	218	171	140	106	83	71	62	53	44	39	35	28	23	21	19	17	16
Clark Fork near Galen (# 12323800)	656	1,223	1,160	1,050	851	687	452	305	225	179	144	122	106	91	79	66	59	51	40	27	19	13	10	10
Clark Fork River ds Sand Creek	664	1,238	1,174	1,060	860	694	457	308	228	182	147	124	108	93	81	67	60	52	41	27	19	13	10	10
Clark Fork River ds Lost Creek	725	1,360	1,284	1,143	934	749	489	329	251	206	169	145	127	110	96	80	71	60	45	29	21	15	12	12
Clark Fork River ds Dry Cottonwood Creek	751	1,413	1,331	1,177	965	772	503	338	261	217	179	154	135	117	102	86	75	63	47	30	22	16	13	13
Clark Fork River ds Modesty Creek	777	1,464	1,378	1,211	996	795	517	346	271	228	190	163	143	125	109	91	80	66	49	31	23	17	14	14
Clark Fork River ds Sand Hollow	788	1,485	1,397	1,225	1,008	804	522	350	275	232	194	167	147	128	112	94	82	68	50	31	23	18	15	14
Clark Fork River ds Racetrack Creek	839	1,589	1,490	1,293	1,070	849	549	367	295	254	215	186	164	144	126	106	92	75	54	33	25	20	17	16
Clark Fork River ds Orofino Creek	862	1,635	1,531	1,322	1,097	869	560	375	304	264	224	195	172	151	133	111	97	78	55	34	26	20	18	17
Clark Fork River ds Caribou-Dempsey Creek	899	1,711	1,599	1,370	1,141	901	579	387	318	281	240	210	185	164	144	121	105	83	58	35	27	22	19	19
Clark Fork River ds Powell Creek	939	1,790	1,670	1,421	1,187	935	599	399	334	298	258	226	200	177	157	131	113	89	61	36	28	24	21	20
Clark Fork River ds Peterson Creek	978	1,870	1,740	1,470	1,233	968	618	412	349	316	275	242	215	191	169	141	122	94	64	37	29	25	23	22
Clark Fork River ds Tin Cup Joe Creek	1,001	1,917	1,782	1,500	1,260	988	630	419	358	327	286	252	224	200	177	148	127	98	66	38	30	26	24	23
Clark Fork at Deer Lodge (# 12324200)	1,001	1,917	1,783	1,500	1,260	988	630	419	358	327	286	252	224	200	177	148	127	98	66	38	30	26	24	23
Clark Fork River ds Taylor Creek	1,011	1,950	1,821	1,536	1,296	1,025	656	434	365	331	290	256	228	204	181	151	130	101	69	40	32	28	26	25
Clark Fork River ds Cottonwood Creek	1,055	2,098	2,000	1,705	1,465	1,200	781	502	397	351	306	272	245	222	198	167	144	113	79	50	43	39	36	35
Clark Fork River ds Spring Gulch	1,070	2,147	2,059	1,761	1,522	1,260	825	526	408	358	311	277	251	227	204	173	149	118	83	54	47	43	40	39
Clark Fork River ds Fred Burr Creek	1,073	2,157	2,071	1,772	1,534	1,272	834	531	410	359	312	278	252	229	205	174	150	119	84	55	48	43	41	39
Clark Fork River ds Mullan Gulch	1,089	2,213	2,140	1,837	1,600	1,344	886	559	422	366	318	284	258	235	212	180	155	124	88	59	53	48	46	44
Clark Fork River ds ONeill Creek	1,121	2,326	2,280	1,972	1,739	1,496	997	618	447	381	330	297	271	249	226	192	167	134	97	69	65	60	58	55
Clark Fork abv Little Blackfoot R. nr Garrison (# 12324400)	1,130	2,358	2,320	2,010	1,779	1,540	1,030	635	454	385	333	300	275	253	230	196	170	137	100	72	68	64	61	59
Clark Fork River ds Little Blackfoot River	1,559	3,834	3,388	2,844	2,477	1,973	1,347	871	662	557	454	395	351	314	281	240	211	177	135	99	81	71	64	61
Clark Fork at Goldcreek (# 12324680)	1,774	4,663	3,947	3,270	2,830	2,180	1,500	989	770	647	514	441	388	343	304	260	230	196	152	112	87	74	65	62

1

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  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.007.000
  Version 7.3         Annual peak flow frequency analysis     Run Date / Time
  10/25/2019                                                   07/29/2020 15:37

                        --- PROCESSING OPTIONS ---

                     Plot option         = Graphics device
                     Basin char output   = TAB-SEPARATED
                     Print option        = Yes
                     Debug print         = No
                     Input peaks listing = Long
                     Input peaks format  = WATSTORE peak file

                     Input files used:
                        peaks (ascii)  -
                        E:\atemp\CFR\17c\WYMT_FFA_2020_WATSTORE.TXT

                        specifications -
                        E:\atemp\CFR\17c\PKFQWPSF.TMP

                     Output file(s):
                        main -
                        E:\atemp\CFR\17c\WYMT_FFA_2020.PRT

                        bcd  -
                        E:\atemp\CFR\17c\WYMT_FFA_2020.BCD



  ***  User responsible for assessment and interpretation of the following analysis  ***
```

1

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  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.001.001
  Version 7.3         Annual peak flow frequency analysis     Run Date / Time
  10/25/2019                                                   07/29/2020 15:37

               Station - 12323800.00  Clark Fork near Galen MT


                    TABLE 1 - INPUT DATA SUMMARY

               Number of peaks in record           =       32
               Peaks not used in analysis          =        0
               Gaged peaks in analysis             =       32
               Historic peaks in analysis          =        0
               Beginning Year                      =     1989
               Ending Year                         =     2020
               Historical Period Length            =       32
               Skew option                         =   WEIGHTED
               Regional skew                       =   -0.070
                    Standard error                 =    0.640
                    Mean Square error              =    0.410
               Gage base discharge                 =      0.0
               User supplied high outlier threshold =   --
               User supplied PILF (LO) criterion   =   --
               Plotting position parameter         =     0.00
               Type of analysis                           EMA
               PILF (LO) Test Method                      MGBT
               Perceptible Ranges:
                   Start Year  End Year  Lower Bound  Upper Bound
                         1989      2020          0.0          INF
                         DEFAULT
               Interval Data                   =   None Specified



    TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS


    WCF002J-CALCS COMPLETED.  RETURN CODE =  2
    EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0
```

MULTIPLE GRUBBS-BECK TEST RESULTS

MULTIPLE GRUBBS-BECK PILF THRESHOLD 323.0
NUMBER OF PILFS IDENTIFIED 4
CLASSIFICATION OF PILFS:
NUMBER OF ZERO FLOWS 0
NUMBER OF CENSORED FLOWS 0
NUMBER OF GAGED PEAKS 4
GAGED PEAKS AND CORRESPONDING P-VALUES
145.0 (0.2328)
150.0 (0.0184)
213.0 (0.0367)
224.0 (0.0048)

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
GAGED PEAKS	0.155	0.218	9.149	32

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.00 Clark Fork near Galen MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA WITHOUT REG SKEW	2.7769	0.2386	-0.691
EMA WITH REG SKEW	2.7802	0.2308	-0.372

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.2193
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.2193

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	127.5	102.3	0.0281	35.7	193.7
0.9900	151.7	127.3	0.0210	50.5	217.8
0.9500	238.6	220.6	0.0089	114.9	304.1
0.9000	299.7	287.7	0.0056	172.9	366.9
0.8000	390.2	387.5	0.0033	273.4	464.6
0.6667	493.2	499.6	0.0023	389.2	581.6
0.5000	622.9	637.1	0.0018	520.9	732.5
0.4292	683.7	699.6	0.0018	577.8	804.2
0.2000	949.3	958.1	0.0019	809.1	1138.0
0.1000	1162.	1147.	0.0023	984.3	1449.0
0.0400	1423.	1358.	0.0033	1183.0	1902.0
0.0200	1611.	1496.	0.0044	1311.0	2285.0
0.0100	1792.	1620.	0.0059	1422.0	2712.0
0.0050	1969.	1731.	0.0077	1519.0	3192.0
0.0020	2196.	1863.	0.0106	1630.0	3926.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will
display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.00 Clark Fork near Galen MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
1989	737.0				
1990	374.0				
1991	795.0				
1992	150.0				
1993	581.0				
1994	428.0				
1995	1120.0				
1996	926.0				
1997	1240.0				
1998	545.0				
1999	610.0				
2000	145.0				
2001	224.0				
2002	324.0				
2003	912.0				
2004	213.0				
2005	571.0				
2006	528.0				
2007	605.0				
2008	787.0				
2009	955.0				
2010	1020.0				
2011	1410.0				
2012	581.0				
2013	323.0				
2014	568.0				
2015	515.0				
2016	426.0				
2017	883.0				
2018	1250.0				
2019	875.0				
2020	975.0				

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.004
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.00 Clark Fork near Galen MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
2011	1410.0	0.0302		
2018	1250.0	0.0605		
1997	1240.0	0.0908		
1995	1120.0	0.1211		
2010	1020.0	0.1515		
2020	975.0	0.1818		
2009	955.0	0.2121		
1996	926.0	0.2424		
2003	912.0	0.2727		
2017	883.0	0.3030		
2019	875.0	0.3333		
1991	795.0	0.3636		
2008	787.0	0.3939		
1989	737.0	0.4242		
1999	610.0	0.4545		
2007	605.0	0.4848		
1993	581.0	0.5455		
2012	581.0	0.5152		
2005	571.0	0.5758		
2014	568.0	0.6061		
1998	545.0	0.6364		
2006	528.0	0.6667		
2015	515.0	0.6970		
1994	428.0	0.7273		
2016	426.0	0.7576		
1990	374.0	0.7879		
2002	324.0	0.8182		
2013	323.0	0.8485		
* 2001	224.0	0.8789		
* 2004	213.0	0.9092		
* 1992	150.0	0.9395		
* 2000	145.0	0.9698		

  * DENOTES PILF (LO)

Station - 12323800.00 Clark Fork near Galen MT

TABLE 7 - EMA REPRESENTATION OF DATA

WATER YEAR	OBSERVED Q_LOWER	OBSERVED Q_UPPER	EMA Q_LOWER	EMA Q_UPPER	USER-ENTERED PERCEPTIBLE RANGES LOWER	USER-ENTERED PERCEPTIBLE RANGES UPPER	FINAL PERCEPTIBLE RANGES LOWER	FINAL PERCEPTIBLE RANGES UPPER
1989	737.0	737.0	737.0	737.0	0.0	INF	323.0	INF
1990	374.0	374.0	374.0	374.0	0.0	INF	323.0	INF
1991	795.0	795.0	795.0	795.0	0.0	INF	323.0	INF
1992	150.0	150.0	0.0	323.0	0.0	INF	323.0	INF
1993	581.0	581.0	581.0	581.0	0.0	INF	323.0	INF
1994	428.0	428.0	428.0	428.0	0.0	INF	323.0	INF
1995	1120.0	1120.0	1120.0	1120.0	0.0	INF	323.0	INF
1996	926.0	926.0	926.0	926.0	0.0	INF	323.0	INF
1997	1240.0	1240.0	1240.0	1240.0	0.0	INF	323.0	INF
1998	545.0	545.0	545.0	545.0	0.0	INF	323.0	INF
1999	610.0	610.0	610.0	610.0	0.0	INF	323.0	INF
2000	145.0	145.0	0.0	323.0	0.0	INF	323.0	INF
2001	224.0	224.0	0.0	323.0	0.0	INF	323.0	INF
2002	324.0	324.0	324.0	324.0	0.0	INF	323.0	INF
2003	912.0	912.0	912.0	912.0	0.0	INF	323.0	INF
2004	213.0	213.0	0.0	323.0	0.0	INF	323.0	INF
2005	571.0	571.0	571.0	571.0	0.0	INF	323.0	INF
2006	528.0	528.0	528.0	528.0	0.0	INF	323.0	INF

2007	605.0	605.0	605.0	605.0	0.0	INF	323.0	INF
2008	787.0	787.0	787.0	787.0	0.0	INF	323.0	INF
2009	955.0	955.0	955.0	955.0	0.0	INF	323.0	INF
2010	1020.0	1020.0	1020.0	1020.0	0.0	INF	323.0	INF
2011	1410.0	1410.0	1410.0	1410.0	0.0	INF	323.0	INF
2012	581.0	581.0	581.0	581.0	0.0	INF	323.0	INF
2013	323.0	323.0	323.0	323.0	0.0	INF	323.0	INF
2014	568.0	568.0	568.0	568.0	0.0	INF	323.0	INF
2015	515.0	515.0	515.0	515.0	0.0	INF	323.0	INF
2016	426.0	426.0	426.0	426.0	0.0	INF	323.0	INF
2017	883.0	883.0	883.0	883.0	0.0	INF	323.0	INF
2018	1250.0	1250.0	1250.0	1250.0	0.0	INF	323.0	INF
2019	875.0	875.0	875.0	875.0	0.0	INF	323.0	INF
2020	975.0	975.0	975.0	975.0	0.0	INF	323.0	INF

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.002.001
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.01 Clark Fork near Galen MT

TABLE 1 - INPUT DATA SUMMARY

Number of peaks in record = 101
Peaks not used in analysis = 0
Gaged peaks in analysis = 101
Historic peaks in analysis = 0
Beginning Year = 1899
Ending Year = 2020
Historical Period Length = 122
Skew option = WEIGHTED
Regional skew = -0.070
Standard error = 0.640
Mean Square error = 0.410
Gage base discharge = 0.0
User supplied high outlier threshold = --
User supplied PILF (LO) criterion = --
Plotting position parameter = 0.00
Type of analysis = EMA
PILF (LO) Test Method = MGBT
Perceptible Ranges:

Start Year	End Year	Lower Bound	Upper Bound	
1899	2020	0.0	INF	
DEFAULT				
1909	1929	2810.0	INF	1908 HISTORICAL SYSTEMATIC SYNTHETIC PERIOD
1				

Interval Data = None Specified

TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS

WCF002J-CALCS COMPLETED. RETURN CODE = 2
EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0

MULTIPLE GRUBBS-BECK TEST RESULTS

MULTIPLE GRUBBS-BECK PILF THRESHOLD 417.0
NUMBER OF PILFS IDENTIFIED 23
CLASSIFICATION OF PILFS:
NUMBER OF ZERO FLOWS 0
NUMBER OF CENSORED FLOWS 0
NUMBER OF GAGED PEAKS 23
GAGED PEAKS AND CORRESPONDING P-VALUES
145.0 (0.5272)
150.0 (0.1872)
179.0 (0.2267)
191.0 (0.1473)
197.0 (0.0665)

213.0	(0.0634)
224.0	(0.0451)
240.0	(0.0513)
250.0	(0.0380)
262.0	(0.0346)
264.0	(0.0126)
288.0	(0.0364)
298.0	(0.0311)
316.0	(0.0542)
323.0	(0.0390)
324.0	(0.0157)
325.0	(0.0054)
328.0	(0.0020)
334.0	(0.0010)
367.0	(0.0102)
367.0	(0.0032)
374.0	(0.0020)
377.0	(0.0007)

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
GAGED PEAKS	-0.042	0.532	-0.669	101

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.002.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.01 Clark Fork near Galen MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA WITHOUT REG SKEW	2.8144	0.2700	-0.570
EMA WITH REG SKEW	2.8187	0.2605	-0.370

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.0717
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.0833

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	114.2	94.6	0.0211	47.5	170.8
0.9900	138.9	119.1	0.0155	65.5	195.8
0.9500	231.5	214.3	0.0059	144.8	286.1
0.9000	299.4	285.8	0.0034	211.5	352.1
0.8000	403.1	396.1	0.0017	321.2	456.0
0.6667	525.2	525.6	0.0010	452.8	584.7
0.5000	683.6	691.8	0.0008	612.1	758.3
0.4292	759.4	770.1	0.0007	683.7	842.5
0.2000	1100.	1111.	0.0008	991.2	1229.0
0.1000	1382.	1380.	0.0009	1239.0	1566.0
0.0400	1738.	1699.	0.0013	1534.0	2029.0
0.0200	1999.	1921.	0.0018	1735.0	2408.0
0.0100	2256.	2129.	0.0024	1917.0	2821.0
0.0050	2508.	2325.	0.0033	2082.0	3272.0
0.0020	2838.	2566.	0.0048	2277.0	3937.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will
display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.
1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.002.003
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.01 Clark Fork near Galen MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
1899	1960.0				
1900	1240.0				
1901	914.0				
1902	1620.0				
1903	1210.0				
1904	776.0				
1905	298.0				
1906	264.0				
1907	816.0				
1908	2810.0				
1930	334.0				
1931	191.0				
1932	610.0				
1933	1060.0				
1934	606.0				
1935	417.0				
1936	651.0				
1937	179.0				
1938	732.0				
1939	367.0				
1940	197.0				
1941	262.0				
1942	1020.0				
1943	982.0				
1944	328.0				
1945	316.0				
1946	250.0				
1947	1090.0				
1948	1150.0				
1949	740.0				
1950	1120.0				
1951	936.0				
1952	621.0				
1953	1230.0				
1954	738.0				
1955	562.0				
1956	982.0				
1957	739.0				
1958	982.0				
1959	607.0				
1960	574.0				
1961	597.0				
1962	510.0				
1963	651.0				
1964	903.0				
1965	1170.0				
1966	288.0				
1967	708.0				
1968	493.0				
1969	550.0				
1970	970.0				
1971	686.0				
1972	940.0				
1973	532.0				
1974	1570.0				
1975	2050.0				
1976	1890.0				

1977	377.0
1978	1020.0
1979	745.0
1980	1110.0
1981	1760.0
1982	910.0
1983	716.0
1984	1030.0
1985	367.0
1986	886.0
1987	240.0
1988	325.0
1989	737.0
1990	374.0
1991	795.0
1992	150.0
1993	581.0
1994	428.0
1995	1120.0
1996	926.0
1997	1240.0
1998	545.0
1999	610.0
2000	145.0
2001	224.0
2002	324.0
2003	912.0
2004	213.0
2005	571.0
2006	528.0
2007	605.0
2008	787.0
2009	955.0
2010	1020.0
2011	1410.0
2012	581.0
2013	323.0
2014	568.0
2015	515.0
2016	426.0
2017	883.0
2018	1250.0
2019	875.0
2020	975.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

Station - 12323800.01 Clark Fork near Galen MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
1908	2810.0	0.0041		
1975	2050.0	0.0180		
1899	1960.0	0.0278		
1976	1890.0	0.0376		
1981	1760.0	0.0475		
1902	1620.0	0.0573		
1974	1570.0	0.0671		
2011	1410.0	0.0769		
2018	1250.0	0.0867		
1900	1240.0	0.1064		
1997	1240.0	0.0966		
1953	1230.0	0.1162		
1903	1210.0	0.1260		
1965	1170.0	0.1358		
1948	1150.0	0.1457		
1950	1120.0	0.1653		
1995	1120.0	0.1555		
1980	1110.0	0.1751		
1947	1090.0	0.1849		
1933	1060.0	0.1948		
1984	1030.0	0.2046		
1942	1020.0	0.2340		
1978	1020.0	0.2242		
2010	1020.0	0.2144		
1943	982.0	0.2635		
1956	982.0	0.2537		
1958	982.0	0.2439		
2020	975.0	0.2733		
1970	970.0	0.2831		
2009	955.0	0.2930		
1972	940.0	0.3028		
1951	936.0	0.3126		
1996	926.0	0.3224		
1901	914.0	0.3322		
2003	912.0	0.3421		
1982	910.0	0.3519		
1964	903.0	0.3617		
1986	886.0	0.3715		
2017	883.0	0.3813		
2019	875.0	0.3912		
1907	816.0	0.4010		
1991	795.0	0.4108		
2008	787.0	0.4206		
1904	776.0	0.4304		
1979	745.0	0.4403		
1949	740.0	0.4501		
1957	739.0	0.4599		
1954	738.0	0.4697		
1989	737.0	0.4795		
1938	732.0	0.4894		
1983	716.0	0.4992		
1967	708.0	0.5090		
1971	686.0	0.5188		
1936	651.0	0.5385		
1963	651.0	0.5286		
1952	621.0	0.5483		
1932	610.0	0.5679		
1999	610.0	0.5581		
1959	607.0	0.5778		
1934	606.0	0.5876		
2007	605.0	0.5974		
1961	597.0	0.6072		
1993	581.0	0.6269		
2012	581.0	0.6170		
1960	574.0	0.6367		
2005	571.0	0.6465		
2014	568.0	0.6563		
1955	562.0	0.6661		
1969	550.0	0.6760		
1998	545.0	0.6858		
1973	532.0	0.6956		

	2006	528.0	0.7054
	2015	515.0	0.7152
	1962	510.0	0.7251
	1968	493.0	0.7349
	1994	428.0	0.7447
	2016	426.0	0.7545
	1935	417.0	0.7643
*	1977	377.0	0.7742
*	1990	374.0	0.7840
*	1939	367.0	0.8036
*	1985	367.0	0.7938
*	1930	334.0	0.8134
*	1944	328.0	0.8233
*	1988	325.0	0.8331
*	2002	324.0	0.8429
*	2013	323.0	0.8527
*	1945	316.0	0.8625
*	1905	298.0	0.8724
*	1966	288.0	0.8822
*	1906	264.0	0.8920
*	1941	262.0	0.9018
*	1946	250.0	0.9116
*	1987	240.0	0.9215
*	2001	224.0	0.9313
*	2004	213.0	0.9411
*	1940	197.0	0.9509
*	1931	191.0	0.9607
*	1937	179.0	0.9706
*	1992	150.0	0.9804
*	2000	145.0	0.9902

* DENOTES PILF (LO)

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.002.005
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12323800.01 Clark Fork near Galen MT

TABLE 7 - EMA REPRESENTATION OF DATA

					<---- USER-ENTERED ---->		<-------- FINAL ------->	
WATER	<----- OBSERVED ---->		<-------- EMA ------->		<- PERCEPTIBLE RANGES ->		<- PERCEPTIBLE RANGES ->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER	LOWER	UPPER
1899	1960.0	1960.0	1960.0	1960.0	0.0	INF	417.0	INF
1900	1240.0	1240.0	1240.0	1240.0	0.0	INF	417.0	INF
1901	914.0	914.0	914.0	914.0	0.0	INF	417.0	INF
1902	1620.0	1620.0	1620.0	1620.0	0.0	INF	417.0	INF
1903	1210.0	1210.0	1210.0	1210.0	0.0	INF	417.0	INF
1904	776.0	776.0	776.0	776.0	0.0	INF	417.0	INF
1905	298.0	298.0	0.0	417.0	0.0	INF	417.0	INF
1906	264.0	264.0	0.0	417.0	0.0	INF	417.0	INF
1907	816.0	816.0	816.0	816.0	0.0	INF	417.0	INF
1908	2810.0	2810.0	2810.0	2810.0	0.0	INF	417.0	INF
1909	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1910	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1911	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1912	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1913	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1914	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1915	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1916	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1917	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1918	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1919	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1920	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1921	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1922	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1923	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1924	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1925	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF

1926	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1927	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1928	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1929	0.0	2810.0	0.0	2810.0	2810.0	INF	2810.0	INF
1930	334.0	334.0	0.0	417.0	0.0	INF	417.0	INF
1931	191.0	191.0	0.0	417.0	0.0	INF	417.0	INF
1932	610.0	610.0	610.0	610.0	0.0	INF	417.0	INF
1933	1060.0	1060.0	1060.0	1060.0	0.0	INF	417.0	INF
1934	606.0	606.0	606.0	606.0	0.0	INF	417.0	INF
1935	417.0	417.0	417.0	417.0	0.0	INF	417.0	INF
1936	651.0	651.0	651.0	651.0	0.0	INF	417.0	INF
1937	179.0	179.0	0.0	417.0	0.0	INF	417.0	INF
1938	732.0	732.0	732.0	732.0	0.0	INF	417.0	INF
1939	367.0	367.0	0.0	417.0	0.0	INF	417.0	INF
1940	197.0	197.0	0.0	417.0	0.0	INF	417.0	INF
1941	262.0	262.0	0.0	417.0	0.0	INF	417.0	INF
1942	1020.0	1020.0	1020.0	1020.0	0.0	INF	417.0	INF
1943	982.0	982.0	982.0	982.0	0.0	INF	417.0	INF
1944	328.0	328.0	0.0	417.0	0.0	INF	417.0	INF
1945	316.0	316.0	0.0	417.0	0.0	INF	417.0	INF
1946	250.0	250.0	0.0	417.0	0.0	INF	417.0	INF
1947	1090.0	1090.0	1090.0	1090.0	0.0	INF	417.0	INF
1948	1150.0	1150.0	1150.0	1150.0	0.0	INF	417.0	INF
1949	740.0	740.0	740.0	740.0	0.0	INF	417.0	INF
1950	1120.0	1120.0	1120.0	1120.0	0.0	INF	417.0	INF
1951	936.0	936.0	936.0	936.0	0.0	INF	417.0	INF
1952	621.0	621.0	621.0	621.0	0.0	INF	417.0	INF
1953	1230.0	1230.0	1230.0	1230.0	0.0	INF	417.0	INF
1954	738.0	738.0	738.0	738.0	0.0	INF	417.0	INF
1955	562.0	562.0	562.0	562.0	0.0	INF	417.0	INF
1956	982.0	982.0	982.0	982.0	0.0	INF	417.0	INF
1957	739.0	739.0	739.0	739.0	0.0	INF	417.0	INF
1958	982.0	982.0	982.0	982.0	0.0	INF	417.0	INF
1959	607.0	607.0	607.0	607.0	0.0	INF	417.0	INF
1960	574.0	574.0	574.0	574.0	0.0	INF	417.0	INF
1961	597.0	597.0	597.0	597.0	0.0	INF	417.0	INF
1962	510.0	510.0	510.0	510.0	0.0	INF	417.0	INF
1963	651.0	651.0	651.0	651.0	0.0	INF	417.0	INF
1964	903.0	903.0	903.0	903.0	0.0	INF	417.0	INF
1965	1170.0	1170.0	1170.0	1170.0	0.0	INF	417.0	INF
1966	288.0	288.0	0.0	417.0	0.0	INF	417.0	INF
1967	708.0	708.0	708.0	708.0	0.0	INF	417.0	INF
1968	493.0	493.0	493.0	493.0	0.0	INF	417.0	INF
1969	550.0	550.0	550.0	550.0	0.0	INF	417.0	INF
1970	970.0	970.0	970.0	970.0	0.0	INF	417.0	INF
1971	686.0	686.0	686.0	686.0	0.0	INF	417.0	INF
1972	940.0	940.0	940.0	940.0	0.0	INF	417.0	INF
1973	532.0	532.0	532.0	532.0	0.0	INF	417.0	INF
1974	1570.0	1570.0	1570.0	1570.0	0.0	INF	417.0	INF
1975	2050.0	2050.0	2050.0	2050.0	0.0	INF	417.0	INF
1976	1890.0	1890.0	1890.0	1890.0	0.0	INF	417.0	INF
1977	377.0	377.0	0.0	417.0	0.0	INF	417.0	INF
1978	1020.0	1020.0	1020.0	1020.0	0.0	INF	417.0	INF
1979	745.0	745.0	745.0	745.0	0.0	INF	417.0	INF
1980	1110.0	1110.0	1110.0	1110.0	0.0	INF	417.0	INF
1981	1760.0	1760.0	1760.0	1760.0	0.0	INF	417.0	INF
1982	910.0	910.0	910.0	910.0	0.0	INF	417.0	INF
1983	716.0	716.0	716.0	716.0	0.0	INF	417.0	INF
1984	1030.0	1030.0	1030.0	1030.0	0.0	INF	417.0	INF
1985	367.0	367.0	0.0	417.0	0.0	INF	417.0	INF
1986	886.0	886.0	886.0	886.0	0.0	INF	417.0	INF
1987	240.0	240.0	0.0	417.0	0.0	INF	417.0	INF
1988	325.0	325.0	0.0	417.0	0.0	INF	417.0	INF
1989	737.0	737.0	737.0	737.0	0.0	INF	417.0	INF
1990	374.0	374.0	0.0	417.0	0.0	INF	417.0	INF
1991	795.0	795.0	795.0	795.0	0.0	INF	417.0	INF
1992	150.0	150.0	0.0	417.0	0.0	INF	417.0	INF
1993	581.0	581.0	581.0	581.0	0.0	INF	417.0	INF
1994	428.0	428.0	428.0	428.0	0.0	INF	417.0	INF
1995	1120.0	1120.0	1120.0	1120.0	0.0	INF	417.0	INF
1996	926.0	926.0	926.0	926.0	0.0	INF	417.0	INF
1997	1240.0	1240.0	1240.0	1240.0	0.0	INF	417.0	INF
1998	545.0	545.0	545.0	545.0	0.0	INF	417.0	INF
1999	610.0	610.0	610.0	610.0	0.0	INF	417.0	INF
2000	145.0	145.0	0.0	417.0	0.0	INF	417.0	INF

2001	224.0	224.0	0.0	417.0	0.0	INF	417.0	INF
2002	324.0	324.0	0.0	417.0	0.0	INF	417.0	INF
2003	912.0	912.0	912.0	912.0	0.0	INF	417.0	INF
2004	213.0	213.0	0.0	417.0	0.0	INF	417.0	INF
2005	571.0	571.0	571.0	571.0	0.0	INF	417.0	INF
2006	528.0	528.0	528.0	528.0	0.0	INF	417.0	INF
2007	605.0	605.0	605.0	605.0	0.0	INF	417.0	INF
2008	787.0	787.0	787.0	787.0	0.0	INF	417.0	INF
2009	955.0	955.0	955.0	955.0	0.0	INF	417.0	INF
2010	1020.0	1020.0	1020.0	1020.0	0.0	INF	417.0	INF
2011	1410.0	1410.0	1410.0	1410.0	0.0	INF	417.0	INF
2012	581.0	581.0	581.0	581.0	0.0	INF	417.0	INF
2013	323.0	323.0	0.0	417.0	0.0	INF	417.0	INF
2014	568.0	568.0	568.0	568.0	0.0	INF	417.0	INF
2015	515.0	515.0	515.0	515.0	0.0	INF	417.0	INF
2016	426.0	426.0	426.0	426.0	0.0	INF	417.0	INF
2017	883.0	883.0	883.0	883.0	0.0	INF	417.0	INF
2018	1250.0	1250.0	1250.0	1250.0	0.0	INF	417.0	INF
2019	875.0	875.0	875.0	875.0	0.0	INF	417.0	INF
2020	975.0	975.0	975.0	975.0	0.0	INF	417.0	INF

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.001
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.00 Clark Fork at Deer Lodge MT

TABLE 1 - INPUT DATA SUMMARY

Number of peaks in record	=	42
Peaks not used in analysis	=	0
Gaged peaks in analysis	=	42
Historic peaks in analysis	=	0
Beginning Year	=	1979
Ending Year	=	2020
Historical Period Length	=	42
Skew option	=	WEIGHTED
Regional skew	=	0.000
Standard error	=	0.640
Mean Square error	=	0.410
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied PILF (LO) criterion	=	--
Plotting position parameter	=	0.00
Type of analysis		EMA
PILF (LO) Test Method		MGBT

Perceptible Ranges:

Start Year	End Year	Lower Bound	Upper Bound
1979	2020	0.0	INF
DEFAULT			

Interval Data = None Specified

TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS

WCF002J-CALCS COMPLETED. RETURN CODE = 2
EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0

MULTIPLE GRUBBS-BECK TEST RESULTS

MULTIPLE GRUBBS-BECK PILF THRESHOLD 613.0
NUMBER OF PILFS IDENTIFIED 12
CLASSIFICATION OF PILFS:
NUMBER OF ZERO FLOWS 0
NUMBER OF CENSORED FLOWS 0
NUMBER OF GAGED PEAKS 12
GAGED PEAKS AND CORRESPONDING P-VALUES
263.0 (0.7017)

286.0 (0.4465)
310.0 (0.2804)
367.0 (0.3972)
381.0 (0.2425)
409.0 (0.1994)
461.0 (0.3118)
462.0 (0.1395)
463.0 (0.0457)
492.0 (0.0333)
507.0 (0.0132)
514.0 (0.0030)

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
GAGED PEAKS	0.016	0.888	1.500	42

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.00 Clark Fork at Deer Lodge MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA WITHOUT REG SKEW	2.9257	0.3393	-1.116
EMA WITH REG SKEW	2.9529	0.2843	-0.337

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.2569
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.2569

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	135.2	51.0	0.0547	22.8	243.5
0.9900	166.7	75.0	0.0414	35.6	276.6
0.9500	288.1	191.5	0.0178	104.7	398.3
0.9000	380.0	295.6	0.0108	171.4	489.4
0.8000	524.2	471.5	0.0058	287.0	636.8
0.6667	698.4	689.5	0.0034	461.3	827.3
0.5000	930.9	971.7	0.0023	734.6	1102.0
0.4292	1044.	1103.	0.0021	855.0	1240.0
0.2000	1569.	1634.	0.0022	1323.0	1919.0
0.1000	2021.	1997.	0.0029	1681.0	2588.0
0.0400	2608.	2359.	0.0042	2112.0	3607.0
0.0200	3050.	2568.	0.0056	2409.0	4491.0
0.0100	3494.	2735.	0.0074	2682.0	5491.0
0.0050	3940.	2869.	0.0095	2933.0	6630.0
0.0020	4532.	3006.	0.0129	3234.0	8398.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will
display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.
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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.003

Station - 12324200.00 Clark Fork at Deer Lodge MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
1979	697.0				
1980	1710.0				
1981	2500.0				
1982	1450.0				
1983	1190.0				
1984	1730.0				
1985	492.0				
1986	2090.0				
1987	463.0				
1988	409.0				
1989	1430.0				
1990	507.0				
1991	1020.0				
1992	367.0				
1993	613.0				
1994	462.0				
1995	1240.0				
1996	1400.0				
1997	2020.0				
1998	1200.0				
1999	819.0				
2000	263.0				
2001	310.0				
2002	461.0				
2003	1060.0				
2004	286.0				
2005	848.0				
2006	654.0				
2007	1130.0				
2008	1020.0				
2009	1180.0				
2010	1540.0				
2011	1970.0				
2012	840.0				
2013	381.0				
2014	1190.0				
2015	647.0				
2016	514.0				
2017	1710.0				
2018	2290.0				
2019	1320.0				
2020	1770.0				

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.004
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.00 Clark Fork at Deer Lodge MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

	WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
	1981	2500.0	0.0232		
	2018	2290.0	0.0465		
	1986	2090.0	0.0697		
	1997	2020.0	0.0930		
	2011	1970.0	0.1162		
	2020	1770.0	0.1395		
	1984	1730.0	0.1627		
	1980	1710.0	0.2093		
	2017	1710.0	0.1860		
	2010	1540.0	0.2325		
	1982	1450.0	0.2558		
	1989	1430.0	0.2790		
	1996	1400.0	0.3023		
	2019	1320.0	0.3256		
	1995	1240.0	0.3488		
	1998	1200.0	0.3721		
	1983	1190.0	0.4186		
	2014	1190.0	0.3953		
	2009	1180.0	0.4419		
	2007	1130.0	0.4651		
	2003	1060.0	0.4884		
	1991	1020.0	0.5349		
	2008	1020.0	0.5116		
	2005	848.0	0.5581		
	2012	840.0	0.5814		
	1999	819.0	0.6047		
	1979	697.0	0.6279		
	2006	654.0	0.6512		
	2015	647.0	0.6744		
	1993	613.0	0.6977		
*	2016	514.0	0.7210		
*	1990	507.0	0.7442		
*	1985	492.0	0.7675		
*	1987	463.0	0.7907		
*	1994	462.0	0.8140		
*	2002	461.0	0.8373		
*	1988	409.0	0.8605		
*	2013	381.0	0.8838		
*	1992	367.0	0.9070		
*	2001	310.0	0.9303		
*	2004	286.0	0.9535		
*	2000	263.0	0.9768		

* DENOTES PILF (LO)

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.005
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.00 Clark Fork at Deer Lodge MT

TABLE 7 - EMA REPRESENTATION OF DATA

	<---- USER-ENTERED ---->		<-------- FINAL ------->					
WATER <----- OBSERVED ---->			<-------- EMA ------->		<- PERCEPTIBLE RANGES ->		<- PERCEPTIBLE RANGES ->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER	LOWER	UPPER
1979	697.0	697.0	697.0	697.0	0.0	INF	613.0	INF
1980	1710.0	1710.0	1710.0	1710.0	0.0	INF	613.0	INF

1981	2500.0	2500.0	2500.0	2500.0	0.0	INF	613.0	INF
1982	1450.0	1450.0	1450.0	1450.0	0.0	INF	613.0	INF
1983	1190.0	1190.0	1190.0	1190.0	0.0	INF	613.0	INF
1984	1730.0	1730.0	1730.0	1730.0	0.0	INF	613.0	INF
1985	492.0	492.0	0.0	613.0	0.0	INF	613.0	INF
1986	2090.0	2090.0	2090.0	2090.0	0.0	INF	613.0	INF
1987	463.0	463.0	0.0	613.0	0.0	INF	613.0	INF
1988	409.0	409.0	0.0	613.0	0.0	INF	613.0	INF
1989	1430.0	1430.0	1430.0	1430.0	0.0	INF	613.0	INF
1990	507.0	507.0	0.0	613.0	0.0	INF	613.0	INF
1991	1020.0	1020.0	1020.0	1020.0	0.0	INF	613.0	INF
1992	367.0	367.0	0.0	613.0	0.0	INF	613.0	INF
1993	613.0	613.0	613.0	613.0	0.0	INF	613.0	INF
1994	462.0	462.0	0.0	613.0	0.0	INF	613.0	INF
1995	1240.0	1240.0	1240.0	1240.0	0.0	INF	613.0	INF
1996	1400.0	1400.0	1400.0	1400.0	0.0	INF	613.0	INF
1997	2020.0	2020.0	2020.0	2020.0	0.0	INF	613.0	INF
1998	1200.0	1200.0	1200.0	1200.0	0.0	INF	613.0	INF
1999	819.0	819.0	819.0	819.0	0.0	INF	613.0	INF
2000	263.0	263.0	0.0	613.0	0.0	INF	613.0	INF
2001	310.0	310.0	0.0	613.0	0.0	INF	613.0	INF
2002	461.0	461.0	0.0	613.0	0.0	INF	613.0	INF
2003	1060.0	1060.0	1060.0	1060.0	0.0	INF	613.0	INF
2004	286.0	286.0	0.0	613.0	0.0	INF	613.0	INF
2005	848.0	848.0	848.0	848.0	0.0	INF	613.0	INF
2006	654.0	654.0	654.0	654.0	0.0	INF	613.0	INF
2007	1130.0	1130.0	1130.0	1130.0	0.0	INF	613.0	INF
2008	1020.0	1020.0	1020.0	1020.0	0.0	INF	613.0	INF
2009	1180.0	1180.0	1180.0	1180.0	0.0	INF	613.0	INF
2010	1540.0	1540.0	1540.0	1540.0	0.0	INF	613.0	INF
2011	1970.0	1970.0	1970.0	1970.0	0.0	INF	613.0	INF
2012	840.0	840.0	840.0	840.0	0.0	INF	613.0	INF
2013	381.0	381.0	0.0	613.0	0.0	INF	613.0	INF
2014	1190.0	1190.0	1190.0	1190.0	0.0	INF	613.0	INF
2015	647.0	647.0	647.0	647.0	0.0	INF	613.0	INF
2016	514.0	514.0	0.0	613.0	0.0	INF	613.0	INF
2017	1710.0	1710.0	1710.0	1710.0	0.0	INF	613.0	INF
2018	2290.0	2290.0	2290.0	2290.0	0.0	INF	613.0	INF
2019	1320.0	1320.0	1320.0	1320.0	0.0	INF	613.0	INF
2020	1770.0	1770.0	1770.0	1770.0	0.0	INF	613.0	INF

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.001
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.01 Clark Fork at Deer Lodge MT

TABLE 1 - INPUT DATA SUMMARY

Number of peaks in record	=	101
Peaks not used in analysis	=	0
Gaged peaks in analysis	=	101
Historic peaks in analysis	=	0
Beginning Year	=	1899
Ending Year	=	2020
Historical Period Length	=	122
Skew option	=	WEIGHTED
Regional skew	=	0.000
Standard error	=	0.640
Mean Square error	=	0.410
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied PILF (LO) criterion	=	--
Plotting position parameter	=	0.00
Type of analysis		EMA
PILF (LO) Test Method		MGBT

Perceptible Ranges:

Start Year	End Year	Lower Bound	Upper Bound	
1899	2020	0.0	INF	
DEFAULT				
1909	1929	4670.0	INF	1908 HISTORICAL SYSTEMATIC SYNTHETIC PERIOD
1				

Interval Data = None Specified

TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS

WCF002J-CALCS COMPLETED. RETURN CODE = 2
EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0

MULTIPLE GRUBBS-BECK TEST RESULTS
MULTIPLE GRUBBS-BECK PILF THRESHOLD N/A
NUMBER OF PILFS IDENTIFIED 0

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
GAGED PEAKS	-0.027	0.694	-0.775	101

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.01 Clark Fork at Deer Lodge MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOGARITHMIC

	MEAN	STANDARD DEVIATION	SKEW
EMA WITHOUT REG SKEW	2.9761	0.2718	-0.070
EMA WITH REG SKEW	2.9761	0.2718	-0.061

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.0533
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.0562

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	182.2	181.2	0.0057	121.1	234.5
0.9900	214.6	213.7	0.0042	152.0	267.3
0.9500	334.5	334.0	0.0019	270.8	389.8
0.9000	422.8	422.5	0.0013	358.8	482.3
0.8000	560.1	560.2	0.0010	491.7	629.5
0.6667	726.6	727.2	0.0009	647.1	811.9
0.5000	952.6	953.5	0.0008	853.0	1063.0
0.4292	1065.	1066.	0.0008	954.3	1190.0
0.2000	1606.	1606.	0.0010	1433.0	1814.0
0.1000	2102.	2101.	0.0014	1854.0	2434.0
0.0400	2793.	2788.	0.0022	2403.0	3401.0
0.0200	3352.	3342.	0.0032	2814.0	4272.0
0.0100	3946.	3930.	0.0045	3219.0	5281.0
0.0050	4577.	4553.	0.0062	3620.0	6449.0
0.0020	5472.	5436.	0.0089	4145.0	8273.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.003
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.01 Clark Fork at Deer Lodge MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
1899	3250.0				
1900	2050.0				
1901	1500.0				
1902	2680.0				
1903	1990.0				
1904	1270.0				
1905	484.0				
1906	428.0				
1907	1340.0				
1908	4670.0				
1930	537.0				
1931	189.0				
1932	827.0				
1933	1640.0				
1934	1040.0				
1935	622.0				
1936	810.0				
1937	432.0				
1938	1330.0				
1939	525.0				
1940	420.0				
1941	425.0				
1942	1740.0				
1943	1450.0				
1944	835.0				
1945	586.0				
1946	548.0				
1947	1080.0				
1948	2130.0				
1949	772.0				
1950	1250.0				
1951	993.0				
1952	490.0				
1953	2140.0				
1954	607.0				
1955	746.0				
1956	928.0				
1957	1050.0				
1958	1060.0				
1959	1070.0				
1960	746.0				
1961	814.0				
1962	783.0				
1963	665.0				
1964	1670.0				
1965	1460.0				
1966	324.0				
1967	1020.0				
1968	820.0				
1969	556.0				
1970	1200.0				
1971	704.0				
1972	1320.0				
1973	723.0				
1974	2260.0				
1975	2990.0				
1976	2730.0				
1977	503.0				
1978	1430.0				
1979	697.0				
1980	1710.0				
1981	2500.0				

1982	1450.0
1983	1190.0
1984	1730.0
1985	492.0
1986	2090.0
1987	463.0
1988	409.0
1989	1430.0
1990	507.0
1991	1020.0
1992	367.0
1993	613.0
1994	462.0
1995	1240.0
1996	1400.0
1997	2020.0
1998	1200.0
1999	819.0
2000	263.0
2001	310.0
2002	461.0
2003	1060.0
2004	286.0
2005	848.0
2006	654.0
2007	1130.0
2008	1020.0
2009	1180.0
2010	1540.0
2011	1970.0
2012	840.0
2013	381.0
2014	1190.0
2015	647.0
2016	514.0
2017	1710.0
2018	2290.0
2019	1320.0
2020	1770.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.004
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324200.01 Clark Fork at Deer Lodge MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
1908	4670.0	0.0041		

1899	3250.0	0.0180
1975	2990.0	0.0278
1976	2730.0	0.0376
1902	2680.0	0.0475
1981	2500.0	0.0573
2018	2290.0	0.0671
1974	2260.0	0.0769
1953	2140.0	0.0867
1948	2130.0	0.0966
1986	2090.0	0.1064
1900	2050.0	0.1162
1997	2020.0	0.1260
1903	1990.0	0.1358
2011	1970.0	0.1457
2020	1770.0	0.1555
1942	1740.0	0.1653
1984	1730.0	0.1751
1980	1710.0	0.1948
2017	1710.0	0.1849
1964	1670.0	0.2046
1933	1640.0	0.2144
2010	1540.0	0.2242
1901	1500.0	0.2340
1965	1460.0	0.2439
1943	1450.0	0.2635
1982	1450.0	0.2537
1978	1430.0	0.2831
1989	1430.0	0.2733
1996	1400.0	0.2930
1907	1340.0	0.3028
1938	1330.0	0.3126
1972	1320.0	0.3322
2019	1320.0	0.3224
1904	1270.0	0.3421
1950	1250.0	0.3519
1995	1240.0	0.3617
1970	1200.0	0.3813
1998	1200.0	0.3715
1983	1190.0	0.4010
2014	1190.0	0.3912
2009	1180.0	0.4108
2007	1130.0	0.4206
1947	1080.0	0.4304
1959	1070.0	0.4403
1958	1060.0	0.4599
2003	1060.0	0.4501
1957	1050.0	0.4697
1934	1040.0	0.4795
1967	1020.0	0.5090
1991	1020.0	0.4992
2008	1020.0	0.4894
1951	993.0	0.5188
1956	928.0	0.5286
2005	848.0	0.5385
2012	840.0	0.5483
1944	835.0	0.5581
1932	827.0	0.5679
1968	820.0	0.5778
1999	819.0	0.5876
1961	814.0	0.5974
1936	810.0	0.6072
1962	783.0	0.6170
1949	772.0	0.6269
1955	746.0	0.6465
1960	746.0	0.6367
1973	723.0	0.6563
1971	704.0	0.6661
1979	697.0	0.6760
1963	665.0	0.6858
2006	654.0	0.6956
2015	647.0	0.7054
1935	622.0	0.7152
1993	613.0	0.7251
1954	607.0	0.7349
1945	586.0	0.7447

1969	556.0	0.7545
1946	548.0	0.7643
1930	537.0	0.7742
1939	525.0	0.7840
2016	514.0	0.7938
1990	507.0	0.8036
1977	503.0	0.8134
1985	492.0	0.8233
1952	490.0	0.8331
1905	484.0	0.8429
1987	463.0	0.8527
1994	462.0	0.8625
2002	461.0	0.8724
1937	432.0	0.8822
1906	428.0	0.8920
1941	425.0	0.9018
1940	420.0	0.9116
1988	409.0	0.9215
2013	381.0	0.9313
1992	367.0	0.9411
1966	324.0	0.9509
2001	310.0	0.9607
2004	286.0	0.9706
2000	263.0	0.9804
1931	189.0	0.9902

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.005
Version 7.3 Annual peak flow frequency analysis Run Date / Time
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Station - 12324200.01 Clark Fork at Deer Lodge MT

TABLE 7 - EMA REPRESENTATION OF DATA

					<---- USER-ENTERED ---->		<-------- FINAL ------->	
WATER	<----- OBSERVED ---->		<-------- EMA ------->		<- PERCEPTIBLE RANGES ->		<- PERCEPTIBLE RANGES ->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER	LOWER	UPPER
1899	3250.0	3250.0	3250.0	3250.0	0.0	INF	0.0	INF
1900	2050.0	2050.0	2050.0	2050.0	0.0	INF	0.0	INF
1901	1500.0	1500.0	1500.0	1500.0	0.0	INF	0.0	INF
1902	2680.0	2680.0	2680.0	2680.0	0.0	INF	0.0	INF
1903	1990.0	1990.0	1990.0	1990.0	0.0	INF	0.0	INF
1904	1270.0	1270.0	1270.0	1270.0	0.0	INF	0.0	INF
1905	484.0	484.0	484.0	484.0	0.0	INF	0.0	INF
1906	428.0	428.0	428.0	428.0	0.0	INF	0.0	INF
1907	1340.0	1340.0	1340.0	1340.0	0.0	INF	0.0	INF
1908	4670.0	4670.0	4670.0	4670.0	0.0	INF	0.0	INF
1909	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1910	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1911	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1912	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1913	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1914	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1915	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1916	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1917	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1918	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1919	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1920	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1921	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1922	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1923	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1924	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1925	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1926	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1927	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1928	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1929	0.0	4670.0	0.0	4670.0	4670.0	INF	4670.0	INF
1930	537.0	537.0	537.0	537.0	0.0	INF	0.0	INF
1931	189.0	189.0	189.0	189.0	0.0	INF	0.0	INF
1932	827.0	827.0	827.0	827.0	0.0	INF	0.0	INF
1933	1640.0	1640.0	1640.0	1640.0	0.0	INF	0.0	INF

1934	1040.0	1040.0	1040.0	1040.0	0.0	INF	0.0	INF
1935	622.0	622.0	622.0	622.0	0.0	INF	0.0	INF
1936	810.0	810.0	810.0	810.0	0.0	INF	0.0	INF
1937	432.0	432.0	432.0	432.0	0.0	INF	0.0	INF
1938	1330.0	1330.0	1330.0	1330.0	0.0	INF	0.0	INF
1939	525.0	525.0	525.0	525.0	0.0	INF	0.0	INF
1940	420.0	420.0	420.0	420.0	0.0	INF	0.0	INF
1941	425.0	425.0	425.0	425.0	0.0	INF	0.0	INF
1942	1740.0	1740.0	1740.0	1740.0	0.0	INF	0.0	INF
1943	1450.0	1450.0	1450.0	1450.0	0.0	INF	0.0	INF
1944	835.0	835.0	835.0	835.0	0.0	INF	0.0	INF
1945	586.0	586.0	586.0	586.0	0.0	INF	0.0	INF
1946	548.0	548.0	548.0	548.0	0.0	INF	0.0	INF
1947	1080.0	1080.0	1080.0	1080.0	0.0	INF	0.0	INF
1948	2130.0	2130.0	2130.0	2130.0	0.0	INF	0.0	INF
1949	772.0	772.0	772.0	772.0	0.0	INF	0.0	INF
1950	1250.0	1250.0	1250.0	1250.0	0.0	INF	0.0	INF
1951	993.0	993.0	993.0	993.0	0.0	INF	0.0	INF
1952	490.0	490.0	490.0	490.0	0.0	INF	0.0	INF
1953	2140.0	2140.0	2140.0	2140.0	0.0	INF	0.0	INF
1954	607.0	607.0	607.0	607.0	0.0	INF	0.0	INF
1955	746.0	746.0	746.0	746.0	0.0	INF	0.0	INF
1956	928.0	928.0	928.0	928.0	0.0	INF	0.0	INF
1957	1050.0	1050.0	1050.0	1050.0	0.0	INF	0.0	INF
1958	1060.0	1060.0	1060.0	1060.0	0.0	INF	0.0	INF
1959	1070.0	1070.0	1070.0	1070.0	0.0	INF	0.0	INF
1960	746.0	746.0	746.0	746.0	0.0	INF	0.0	INF
1961	814.0	814.0	814.0	814.0	0.0	INF	0.0	INF
1962	783.0	783.0	783.0	783.0	0.0	INF	0.0	INF
1963	665.0	665.0	665.0	665.0	0.0	INF	0.0	INF
1964	1670.0	1670.0	1670.0	1670.0	0.0	INF	0.0	INF
1965	1460.0	1460.0	1460.0	1460.0	0.0	INF	0.0	INF
1966	324.0	324.0	324.0	324.0	0.0	INF	0.0	INF
1967	1020.0	1020.0	1020.0	1020.0	0.0	INF	0.0	INF
1968	820.0	820.0	820.0	820.0	0.0	INF	0.0	INF
1969	556.0	556.0	556.0	556.0	0.0	INF	0.0	INF
1970	1200.0	1200.0	1200.0	1200.0	0.0	INF	0.0	INF
1971	704.0	704.0	704.0	704.0	0.0	INF	0.0	INF
1972	1320.0	1320.0	1320.0	1320.0	0.0	INF	0.0	INF
1973	723.0	723.0	723.0	723.0	0.0	INF	0.0	INF
1974	2260.0	2260.0	2260.0	2260.0	0.0	INF	0.0	INF
1975	2990.0	2990.0	2990.0	2990.0	0.0	INF	0.0	INF
1976	2730.0	2730.0	2730.0	2730.0	0.0	INF	0.0	INF
1977	503.0	503.0	503.0	503.0	0.0	INF	0.0	INF
1978	1430.0	1430.0	1430.0	1430.0	0.0	INF	0.0	INF
1979	697.0	697.0	697.0	697.0	0.0	INF	0.0	INF
1980	1710.0	1710.0	1710.0	1710.0	0.0	INF	0.0	INF
1981	2500.0	2500.0	2500.0	2500.0	0.0	INF	0.0	INF
1982	1450.0	1450.0	1450.0	1450.0	0.0	INF	0.0	INF
1983	1190.0	1190.0	1190.0	1190.0	0.0	INF	0.0	INF
1984	1730.0	1730.0	1730.0	1730.0	0.0	INF	0.0	INF
1985	492.0	492.0	492.0	492.0	0.0	INF	0.0	INF
1986	2090.0	2090.0	2090.0	2090.0	0.0	INF	0.0	INF
1987	463.0	463.0	463.0	463.0	0.0	INF	0.0	INF
1988	409.0	409.0	409.0	409.0	0.0	INF	0.0	INF
1989	1430.0	1430.0	1430.0	1430.0	0.0	INF	0.0	INF
1990	507.0	507.0	507.0	507.0	0.0	INF	0.0	INF
1991	1020.0	1020.0	1020.0	1020.0	0.0	INF	0.0	INF
1992	367.0	367.0	367.0	367.0	0.0	INF	0.0	INF
1993	613.0	613.0	613.0	613.0	0.0	INF	0.0	INF
1994	462.0	462.0	462.0	462.0	0.0	INF	0.0	INF
1995	1240.0	1240.0	1240.0	1240.0	0.0	INF	0.0	INF
1996	1400.0	1400.0	1400.0	1400.0	0.0	INF	0.0	INF
1997	2020.0	2020.0	2020.0	2020.0	0.0	INF	0.0	INF
1998	1200.0	1200.0	1200.0	1200.0	0.0	INF	0.0	INF
1999	819.0	819.0	819.0	819.0	0.0	INF	0.0	INF
2000	263.0	263.0	263.0	263.0	0.0	INF	0.0	INF
2001	310.0	310.0	310.0	310.0	0.0	INF	0.0	INF
2002	461.0	461.0	461.0	461.0	0.0	INF	0.0	INF
2003	1060.0	1060.0	1060.0	1060.0	0.0	INF	0.0	INF
2004	286.0	286.0	286.0	286.0	0.0	INF	0.0	INF
2005	848.0	848.0	848.0	848.0	0.0	INF	0.0	INF
2006	654.0	654.0	654.0	654.0	0.0	INF	0.0	INF
2007	1130.0	1130.0	1130.0	1130.0	0.0	INF	0.0	INF
2008	1020.0	1020.0	1020.0	1020.0	0.0	INF	0.0	INF

2009	1180.0	1180.0	1180.0	1180.0	0.0	INF	0.0	INF
2010	1540.0	1540.0	1540.0	1540.0	0.0	INF	0.0	INF
2011	1970.0	1970.0	1970.0	1970.0	0.0	INF	0.0	INF
2012	840.0	840.0	840.0	840.0	0.0	INF	0.0	INF
2013	381.0	381.0	381.0	381.0	0.0	INF	0.0	INF
2014	1190.0	1190.0	1190.0	1190.0	0.0	INF	0.0	INF
2015	647.0	647.0	647.0	647.0	0.0	INF	0.0	INF
2016	514.0	514.0	514.0	514.0	0.0	INF	0.0	INF
2017	1710.0	1710.0	1710.0	1710.0	0.0	INF	0.0	INF
2018	2290.0	2290.0	2290.0	2290.0	0.0	INF	0.0	INF
2019	1320.0	1320.0	1320.0	1320.0	0.0	INF	0.0	INF
2020	1770.0	1770.0	1770.0	1770.0	0.0	INF	0.0	INF

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.001
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.00 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 1 - INPUT DATA SUMMARY

Number of peaks in record	= 12
Peaks not used in analysis	= 0
Gaged peaks in analysis	= 12
Historic peaks in analysis	= 0
Beginning Year	= 2009
Ending Year	= 2020
Historical Period Length	= 12
Skew option	= WEIGHTED
Regional skew	= 0.031
Standard error	= 0.640
Mean Square error	= 0.410
Gage base discharge	= 0.0
User supplied high outlier threshold	= --
User supplied PILF (LO) criterion	= --
Plotting position parameter	= 0.00
Type of analysis	EMA
PILF (LO) Test Method	MGBT

Perceptible Ranges:

Start Year	End Year	Lower Bound	Upper Bound
2009	2020	0.0	INF
DEFAULT			

Interval Data = None Specified

TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS

WCF002J-CALCS COMPLETED. RETURN CODE = 2
EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0

MULTIPLE GRUBBS-BECK TEST RESULTS
MULTIPLE GRUBBS-BECK PILF THRESHOLD N/A
NUMBER OF PILFS IDENTIFIED 0

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
GAGED PEAKS	0.030	0.945	13.833	12

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.00 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOGARITHMIC

	LOGARITHMIC MEAN	LOGARITHMIC STANDARD DEVIATION	LOGARITHMIC SKEW
EMA WITHOUT REG SKEW	3.1185	0.2479	-0.646
EMA WITH REG SKEW	3.1185	0.2479	-0.289

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.4576
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.4576

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	258.9	214.7	0.0381	63.7	437.1
0.9900	309.0	267.8	0.0297	93.4	496.0
0.9500	491.5	468.4	0.0152	231.0	711.4
0.9000	622.6	614.8	0.0110	345.0	869.5
0.8000	820.6	834.5	0.0079	523.3	1114.0
0.6667	1052.	1085.	0.0063	728.5	1406.0
0.5000	1350.	1396.	0.0055	983.0	1799.0
0.4292	1493.	1540.	0.0053	1101.0	1996.0
0.2000	2137.	2143.	0.0057	1607.0	3032.0
0.1000	2676.	2595.	0.0070	2008.0	4197.0
0.0400	3364.	3111.	0.0101	2471.0	6168.0
0.0200	3877.	3455.	0.0133	2767.0	8010.0
0.0100	4387.	3769.	0.0173	3020.0	10220.0
0.0050	4896.	4056.	0.0220	3238.0	12870.0
0.0020	5570.	4400.	0.0293	3479.0	17250.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.003
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.00 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
2009	1450.0				
2010	2030.0				
2011	2690.0				
2012	1080.0				
2013	426.0				
2014	1020.0				
2015	826.0				
2016	628.0				
2017	1880.0				
2018	2550.0				
2019	1460.0				
2020	1960.0				

Explanation of peak discharge qualification codes

PeakFQ NWIS

CODE	CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.004
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.00 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
2011	2690.0	0.0767		
2018	2550.0	0.1537		
2010	2030.0	0.2307		
2020	1960.0	0.3076		
2017	1880.0	0.3846		
2019	1460.0	0.4615		
2009	1450.0	0.5385		
2012	1080.0	0.6154		
2014	1020.0	0.6924		
2015	826.0	0.7693		
2016	628.0	0.8463		
2013	426.0	0.9233		

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.005
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.00 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 7 - EMA REPRESENTATION OF DATA

	<---- USER-ENTERED ---->		<-------- FINAL ------->					
WATER YEAR	<----- OBSERVED ----> Q_LOWER	Q_UPPER	<-------- EMA -------> Q_LOWER	Q_UPPER	<- PERCEPTIBLE RANGES -> LOWER	UPPER	<- PERCEPTIBLE RANGES -> LOWER	UPPER
2009	1450.0	1450.0	1450.0	1450.0	0.0	INF	0.0	INF
2010	2030.0	2030.0	2030.0	2030.0	0.0	INF	0.0	INF
2011	2690.0	2690.0	2690.0	2690.0	0.0	INF	0.0	INF
2012	1080.0	1080.0	1080.0	1080.0	0.0	INF	0.0	INF
2013	426.0	426.0	426.0	426.0	0.0	INF	0.0	INF
2014	1020.0	1020.0	1020.0	1020.0	0.0	INF	0.0	INF
2015	826.0	826.0	826.0	826.0	0.0	INF	0.0	INF
2016	628.0	628.0	628.0	628.0	0.0	INF	0.0	INF
2017	1880.0	1880.0	1880.0	1880.0	0.0	INF	0.0	INF
2018	2550.0	2550.0	2550.0	2550.0	0.0	INF	0.0	INF
2019	1460.0	1460.0	1460.0	1460.0	0.0	INF	0.0	INF
2020	1960.0	1960.0	1960.0	1960.0	0.0	INF	0.0	INF

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.001
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.01 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 1 - INPUT DATA SUMMARY

Number of peaks in record	=	83
Peaks not used in analysis	=	0
Gaged peaks in analysis	=	83
Historic peaks in analysis	=	0
Beginning Year	=	1909
Ending Year	=	2020
Historical Period Length	=	112
Skew option	=	WEIGHTED
Regional skew	=	0.031
Standard error	=	0.640
Mean Square error	=	0.410
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied PILF (LO) criterion	=	--
Plotting position parameter	=	0.00
Type of analysis		EMA
PILF (LO) Test Method		MGBT

Perceptible Ranges:

Start Year	End Year	Lower Bound	Upper Bound	
1909	2020	0.0	INF	
DEFAULT				
1909	1937	5590.0	INF	1981 HISTORICAL SYSTEMATIC SYNTHETIC PERIOD
1				

Interval Data = None Specified

TABLE 2 - DIAGNOSTIC MESSAGE AND PILF RESULTS

WCF002J-CALCS COMPLETED. RETURN CODE = 2
EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0

MULTIPLE GRUBBS-BECK TEST RESULTS

MULTIPLE GRUBBS-BECK PILF THRESHOLD 796.0
NUMBER OF PILFS IDENTIFIED 19
CLASSIFICATION OF PILFS:
NUMBER OF ZERO FLOWS 0
NUMBER OF CENSORED FLOWS 0
NUMBER OF GAGED PEAKS 19
GAGED PEAKS AND CORRESPONDING P-VALUES

242.0	(0.2598)
290.0	(0.1335)
377.0	(0.3067)
399.0	(0.1997)
407.0	(0.0837)
426.0	(0.0463)
479.0	(0.0975)
496.0	(0.0619)
503.0	(0.0250)
540.0	(0.0353)
553.0	(0.0185)
608.0	(0.0593)
628.0	(0.0486)
629.0	(0.0175)
632.0	(0.0057)
644.0	(0.0026)
654.0	(0.0010)
708.0	(0.0038)
732.0	(0.0033)

Kendall's Tau Parameters

MEDIAN No. of

	TAU	P-VALUE	SLOPE	PEAKS
GAGED PEAKS	-0.009	0.903	-0.278	83

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.002
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.01 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 3 - ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA WITHOUT REG SKEW	3.0911	0.2699	-0.625
EMA WITH REG SKEW	3.0974	0.2559	-0.332

EMA ESTIMATE OF MSE OF SKEW WITHOUT REG SKEW 0.0802
EMA ESTIMATE OF MSE OF SKEW W/GAGED PEAKS ONLY (AT-SITE) 0.1013

TABLE 4 - ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	228.5	173.5	0.0230	86.8	344.2
0.9900	275.7	220.2	0.0169	119.7	391.1
0.9500	450.5	402.3	0.0066	265.8	560.1
0.9000	577.6	539.7	0.0038	389.8	683.3
0.8000	771.2	751.4	0.0019	596.8	878.0
0.6667	998.2	999.3	0.0012	846.6	1120.0
0.5000	1293.	1315.	0.0009	1146.0	1447.0
0.4292	1434.	1464.	0.0009	1279.0	1605.0
0.2000	2070.	2101.	0.0009	1847.0	2339.0
0.1000	2600.	2594.	0.0011	2303.0	2985.0
0.0400	3273.	3169.	0.0016	2854.0	3888.0
0.0200	3771.	3561.	0.0021	3232.0	4643.0
0.0100	4264.	3923.	0.0029	3579.0	5479.0
0.0050	4753.	4258.	0.0038	3898.0	6409.0
0.0020	5396.	4666.	0.0055	4280.0	7806.0

*Note: If Station Skew option is selected then EMA ESTIMATE WITH REG SKEW will
display values for and be equal to EMA ESTIMATE WITHOUT REG SKEW.

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.003
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.01 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 5 - INPUT DATA LISTING

WATER YEAR	PEAK VALUE	PEAKFQ CODES	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND	REMARKS
1938	1420.0				
1939	708.0				
1940	377.0				
1941	503.0				
1942	1990.0				
1943	1920.0				

1944	632.0
1945	608.0
1946	479.0
1947	2130.0
1948	2250.0
1949	1440.0
1950	2200.0
1951	1830.0
1952	1210.0
1953	2420.0
1954	1440.0
1955	1090.0
1956	1920.0
1957	1440.0
1958	1920.0
1959	1180.0
1960	1110.0
1961	1160.0
1962	988.0
1963	1270.0
1964	1760.0
1965	2290.0
1966	553.0
1967	1700.0
1968	955.0
1969	1070.0
1970	1900.0
1971	1330.0
1972	2810.0
1973	407.0
1974	1980.0
1975	3040.0
1976	2010.0
1977	399.0
1978	1120.0
1979	1230.0
1980	2720.0
1981	5590.0
1982	1660.0
1983	1300.0
1984	1860.0
1985	825.0
1986	3040.0
1987	496.0
1988	540.0
1989	1440.0
1990	912.0
1991	1080.0
1992	242.0
1993	796.0
1994	644.0
1995	1980.0
1996	3410.0
1997	1920.0
1998	1650.0
1999	1170.0
2000	290.0
2001	629.0
2002	654.0
2003	2050.0
2004	732.0
2005	1550.0
2006	1020.0
2007	1300.0
2008	1350.0
2009	1450.0
2010	2030.0
2011	2690.0
2012	1080.0
2013	426.0
2014	1020.0
2015	826.0
2016	628.0
2017	1880.0
2018	2550.0

2019	1460.0
2020	1960.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
O	O	Opportunistic peak
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

Station - 12324400.01 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 6 - EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	FLOW INTERVALS (WHERE LOWER BOUND NOT = UPPER BOUND) LOWER BOUND	UPPER BOUND
1981	5590.0	0.0045		
1996	3410.0	0.0208		
1975	3040.0	0.0447		
1986	3040.0	0.0328		
1972	2810.0	0.0567		
1980	2720.0	0.0686		
2011	2690.0	0.0805		
2018	2550.0	0.0925		
1953	2420.0	0.1044		
1965	2290.0	0.1164		
1948	2250.0	0.1283		
1950	2200.0	0.1403		
1947	2130.0	0.1522		
2003	2050.0	0.1641		
2010	2030.0	0.1761		
1976	2010.0	0.1880		
1942	1990.0	0.2000		
1974	1980.0	0.2238		
1995	1980.0	0.2119		
2020	1960.0	0.2358		
1943	1920.0	0.2835		
1956	1920.0	0.2716		
1958	1920.0	0.2597		
1997	1920.0	0.2477		
1970	1900.0	0.2955		
2017	1880.0	0.3074		
1984	1860.0	0.3194		
1951	1830.0	0.3313		
1964	1760.0	0.3433		
1967	1700.0	0.3552		
1982	1660.0	0.3671		
1998	1650.0	0.3791		
2005	1550.0	0.3910		
2019	1460.0	0.4030		
2009	1450.0	0.4149		
1949	1440.0	0.4627		
1954	1440.0	0.4507		
1957	1440.0	0.4388		

1989	1440.0	0.4268
1938	1420.0	0.4746
2008	1350.0	0.4866
1971	1330.0	0.4985
1983	1300.0	0.5224
2007	1300.0	0.5104
1963	1270.0	0.5343
1979	1230.0	0.5463
1952	1210.0	0.5582
1959	1180.0	0.5701
1999	1170.0	0.5821
1961	1160.0	0.5940
1978	1120.0	0.6060
1960	1110.0	0.6179
1955	1090.0	0.6298
1991	1080.0	0.6537
2012	1080.0	0.6418
1969	1070.0	0.6657
2006	1020.0	0.6896
2014	1020.0	0.6776
1962	988.0	0.7015
1968	955.0	0.7134
1990	912.0	0.7254
2015	826.0	0.7373
1985	825.0	0.7493
1993	796.0	0.7612
* 2004	732.0	0.7731
* 1939	708.0	0.7851
* 2002	654.0	0.7970
* 1994	644.0	0.8090
* 1944	632.0	0.8209
* 2001	629.0	0.8329
* 2016	628.0	0.8448
* 1945	608.0	0.8567
* 1966	553.0	0.8687
* 1988	540.0	0.8806
* 1941	503.0	0.8926
* 1987	496.0	0.9045
* 1946	479.0	0.9164
* 2013	426.0	0.9284
* 1973	407.0	0.9403
* 1977	399.0	0.9523
* 1940	377.0	0.9642
* 2000	290.0	0.9761
* 1992	242.0	0.9881

* DENOTES PILF (LO)

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.005
Version 7.3 Annual peak flow frequency analysis Run Date / Time
10/25/2019 07/29/2020 15:37

Station - 12324400.01 Clark Fork ab Little Blackfoot R nr Garrison MT

TABLE 7 - EMA REPRESENTATION OF DATA

					<---- USER-ENTERED ---->		<-------- FINAL ------->	
WATER	<----- OBSERVED ---->		<-------- EMA ------->		<- PERCEPTIBLE RANGES ->		<- PERCEPTIBLE RANGES ->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER	LOWER	UPPER
1909	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1910	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1911	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1912	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1913	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1914	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1915	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1916	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1917	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1918	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1919	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1920	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF

1921	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1922	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1923	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1924	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1925	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1926	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1927	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1928	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1929	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1930	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1931	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1932	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1933	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1934	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1935	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1936	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1937	0.0	5590.0	0.0	5590.0	5590.0	INF	5590.0	INF
1938	1420.0	1420.0	1420.0	1420.0	0.0	INF	796.0	INF
1939	708.0	708.0	0.0	796.0	0.0	INF	796.0	INF
1940	377.0	377.0	0.0	796.0	0.0	INF	796.0	INF
1941	503.0	503.0	0.0	796.0	0.0	INF	796.0	INF
1942	1990.0	1990.0	1990.0	1990.0	0.0	INF	796.0	INF
1943	1920.0	1920.0	1920.0	1920.0	0.0	INF	796.0	INF
1944	632.0	632.0	0.0	796.0	0.0	INF	796.0	INF
1945	608.0	608.0	0.0	796.0	0.0	INF	796.0	INF
1946	479.0	479.0	0.0	796.0	0.0	INF	796.0	INF
1947	2130.0	2130.0	2130.0	2130.0	0.0	INF	796.0	INF
1948	2250.0	2250.0	2250.0	2250.0	0.0	INF	796.0	INF
1949	1440.0	1440.0	1440.0	1440.0	0.0	INF	796.0	INF
1950	2200.0	2200.0	2200.0	2200.0	0.0	INF	796.0	INF
1951	1830.0	1830.0	1830.0	1830.0	0.0	INF	796.0	INF
1952	1210.0	1210.0	1210.0	1210.0	0.0	INF	796.0	INF
1953	2420.0	2420.0	2420.0	2420.0	0.0	INF	796.0	INF
1954	1440.0	1440.0	1440.0	1440.0	0.0	INF	796.0	INF
1955	1090.0	1090.0	1090.0	1090.0	0.0	INF	796.0	INF
1956	1920.0	1920.0	1920.0	1920.0	0.0	INF	796.0	INF
1957	1440.0	1440.0	1440.0	1440.0	0.0	INF	796.0	INF
1958	1920.0	1920.0	1920.0	1920.0	0.0	INF	796.0	INF
1959	1180.0	1180.0	1180.0	1180.0	0.0	INF	796.0	INF
1960	1110.0	1110.0	1110.0	1110.0	0.0	INF	796.0	INF
1961	1160.0	1160.0	1160.0	1160.0	0.0	INF	796.0	INF
1962	988.0	988.0	988.0	988.0	0.0	INF	796.0	INF
1963	1270.0	1270.0	1270.0	1270.0	0.0	INF	796.0	INF
1964	1760.0	1760.0	1760.0	1760.0	0.0	INF	796.0	INF
1965	2290.0	2290.0	2290.0	2290.0	0.0	INF	796.0	INF
1966	553.0	553.0	0.0	796.0	0.0	INF	796.0	INF
1967	1700.0	1700.0	1700.0	1700.0	0.0	INF	796.0	INF
1968	955.0	955.0	955.0	955.0	0.0	INF	796.0	INF
1969	1070.0	1070.0	1070.0	1070.0	0.0	INF	796.0	INF
1970	1900.0	1900.0	1900.0	1900.0	0.0	INF	796.0	INF
1971	1330.0	1330.0	1330.0	1330.0	0.0	INF	796.0	INF
1972	2810.0	2810.0	2810.0	2810.0	0.0	INF	796.0	INF
1973	407.0	407.0	0.0	796.0	0.0	INF	796.0	INF
1974	1980.0	1980.0	1980.0	1980.0	0.0	INF	796.0	INF
1975	3040.0	3040.0	3040.0	3040.0	0.0	INF	796.0	INF
1976	2010.0	2010.0	2010.0	2010.0	0.0	INF	796.0	INF
1977	399.0	399.0	0.0	796.0	0.0	INF	796.0	INF
1978	1120.0	1120.0	1120.0	1120.0	0.0	INF	796.0	INF
1979	1230.0	1230.0	1230.0	1230.0	0.0	INF	796.0	INF
1980	2720.0	2720.0	2720.0	2720.0	0.0	INF	796.0	INF
1981	5590.0	5590.0	5590.0	5590.0	0.0	INF	796.0	INF
1982	1660.0	1660.0	1660.0	1660.0	0.0	INF	796.0	INF
1983	1300.0	1300.0	1300.0	1300.0	0.0	INF	796.0	INF
1984	1860.0	1860.0	1860.0	1860.0	0.0	INF	796.0	INF
1985	825.0	825.0	825.0	825.0	0.0	INF	796.0	INF
1986	3040.0	3040.0	3040.0	3040.0	0.0	INF	796.0	INF
1987	496.0	496.0	0.0	796.0	0.0	INF	796.0	INF
1988	540.0	540.0	0.0	796.0	0.0	INF	796.0	INF
1989	1440.0	1440.0	1440.0	1440.0	0.0	INF	796.0	INF
1990	912.0	912.0	912.0	912.0	0.0	INF	796.0	INF
1991	1080.0	1080.0	1080.0	1080.0	0.0	INF	796.0	INF
1992	242.0	242.0	0.0	796.0	0.0	INF	796.0	INF
1993	796.0	796.0	796.0	796.0	0.0	INF	796.0	INF
1994	644.0	644.0	0.0	796.0	0.0	INF	796.0	INF
1995	1980.0	1980.0	1980.0	1980.0	0.0	INF	796.0	INF

1996	3410.0	3410.0	3410.0	3410.0	0.0	INF	796.0	INF
1997	1920.0	1920.0	1920.0	1920.0	0.0	INF	796.0	INF
1998	1650.0	1650.0	1650.0	1650.0	0.0	INF	796.0	INF
1999	1170.0	1170.0	1170.0	1170.0	0.0	INF	796.0	INF
2000	290.0	290.0	0.0	796.0	0.0	INF	796.0	INF
2001	629.0	629.0	0.0	796.0	0.0	INF	796.0	INF
2002	654.0	654.0	0.0	796.0	0.0	INF	796.0	INF
2003	2050.0	2050.0	2050.0	2050.0	0.0	INF	796.0	INF
2004	732.0	732.0	0.0	796.0	0.0	INF	796.0	INF
2005	1550.0	1550.0	1550.0	1550.0	0.0	INF	796.0	INF
2006	1020.0	1020.0	1020.0	1020.0	0.0	INF	796.0	INF
2007	1300.0	1300.0	1300.0	1300.0	0.0	INF	796.0	INF
2008	1350.0	1350.0	1350.0	1350.0	0.0	INF	796.0	INF
2009	1450.0	1450.0	1450.0	1450.0	0.0	INF	796.0	INF
2010	2030.0	2030.0	2030.0	2030.0	0.0	INF	796.0	INF
2011	2690.0	2690.0	2690.0	2690.0	0.0	INF	796.0	INF
2012	1080.0	1080.0	1080.0	1080.0	0.0	INF	796.0	INF
2013	426.0	426.0	0.0	796.0	0.0	INF	796.0	INF
2014	1020.0	1020.0	1020.0	1020.0	0.0	INF	796.0	INF
2015	826.0	826.0	826.0	826.0	0.0	INF	796.0	INF
2016	628.0	628.0	0.0	796.0	0.0	INF	796.0	INF
2017	1880.0	1880.0	1880.0	1880.0	0.0	INF	796.0	INF
2018	2550.0	2550.0	2550.0	2550.0	0.0	INF	796.0	INF
2019	1460.0	1460.0	1460.0	1460.0	0.0	INF	796.0	INF
2020	1960.0	1960.0	1960.0	1960.0	0.0	INF	796.0	INF

1

End PeakFQ analysis.
  Stations processed :   6
  Number of errors   :   0
  Stations skipped   :   0
  Station years   :   371

Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4, or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION: 12323800.00   USGS Clark Fork near Galen MT

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION: 12323800.01   USGS Clark Fork near Galen MT

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION: 12324200.00   USGS Clark Fork at Deer Lodge MT

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION: 12324200.01   USGS Clark Fork at Deer Lodge MT

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION: 12324400.00   USGS Clark Fork ab Little Blackfoo

 For the station below, the following records were ignored:

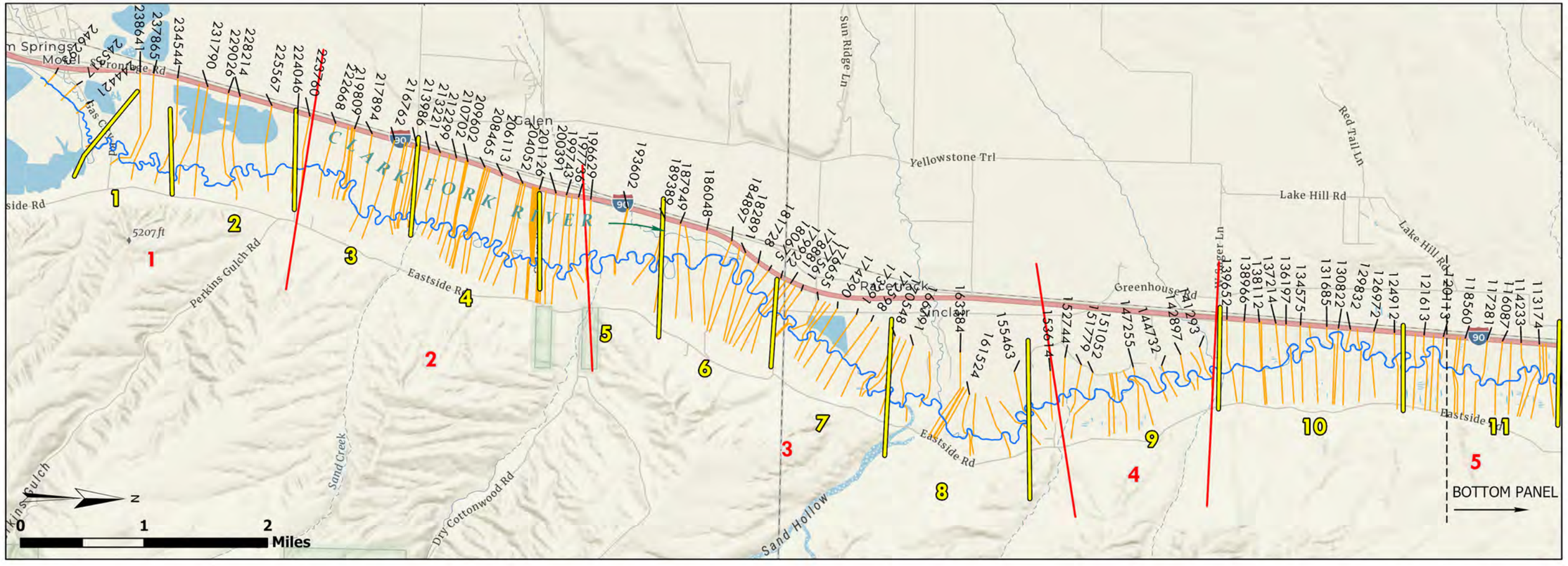
 FINISHED PROCESSING STATION: 12324400.01   USGS Clark Fork ab Little Blackfoo

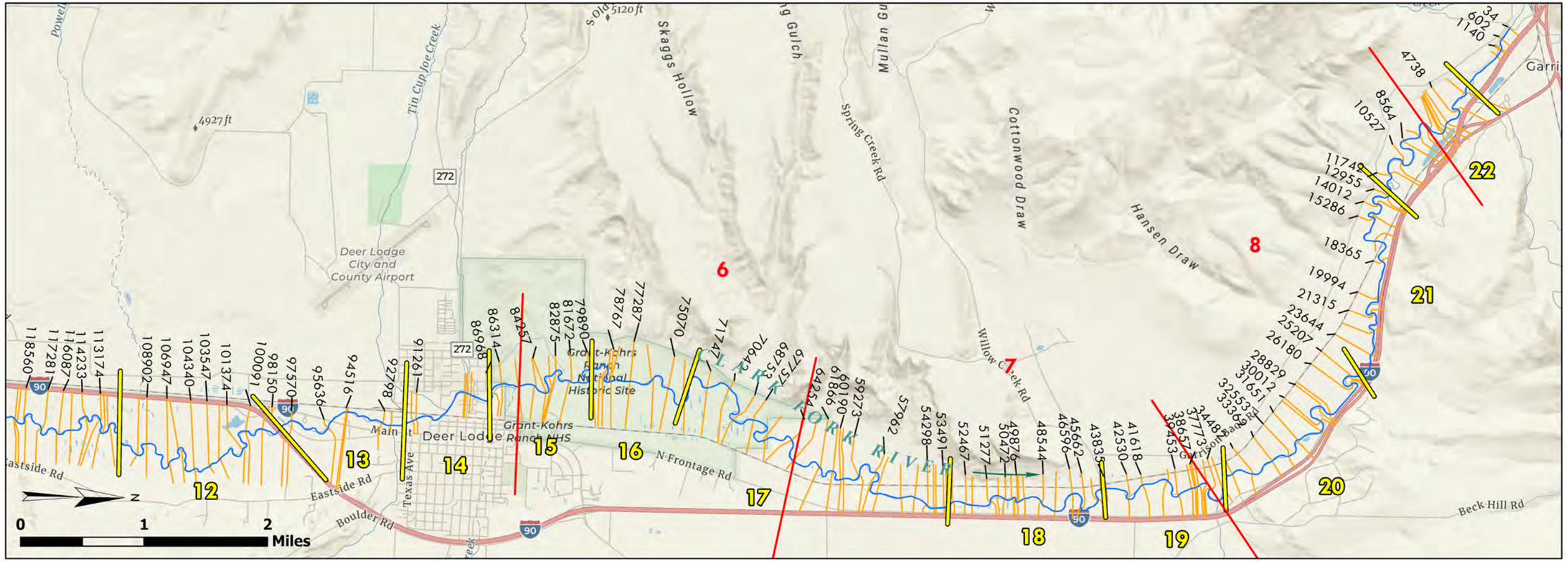
 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:

APPENDIX C – HYDRAULIC MODEL OUTPUT

UPPER CLARK FORK RIVER
REACH A
HEC-RAS MODEL SCHEMATIC



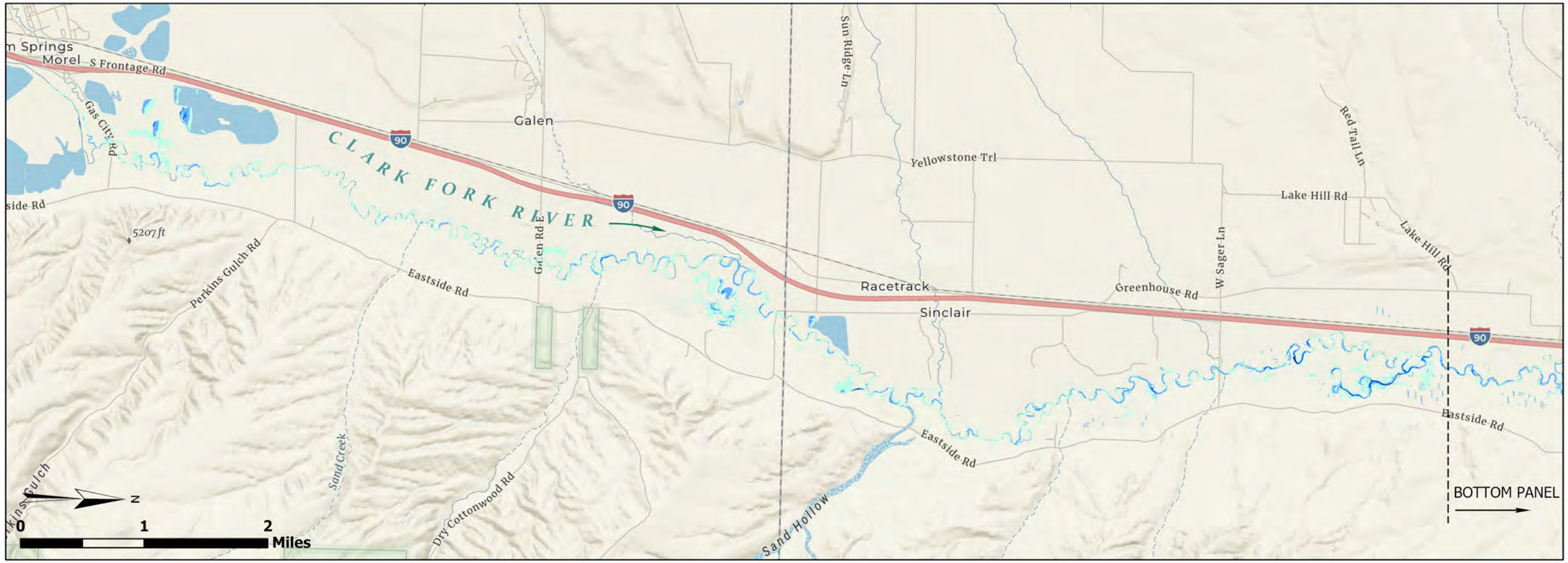


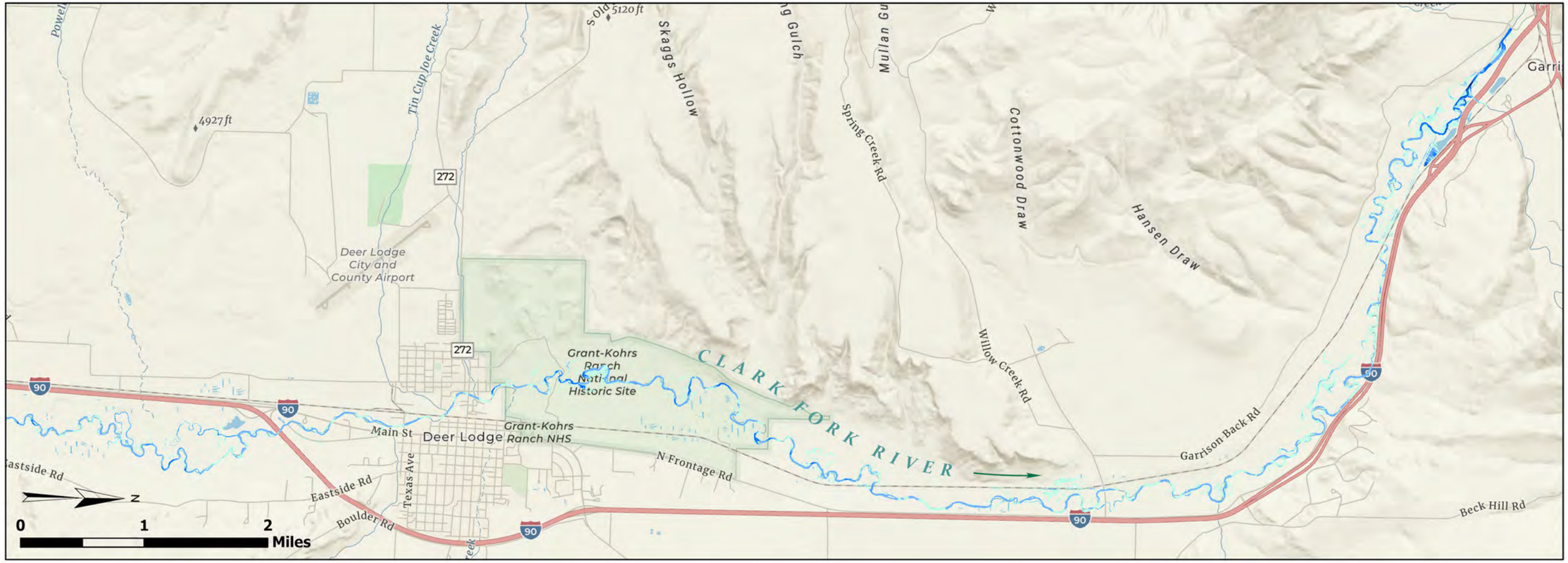
- CENTERLINE
- CROSS-SECTION
- CFROU PHASE
- MODEL REACH

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

UPPER CLARK FORK RIVER
REACH A
HYDRAULIC MODEL OUTPUT





DEPTH Q1.5

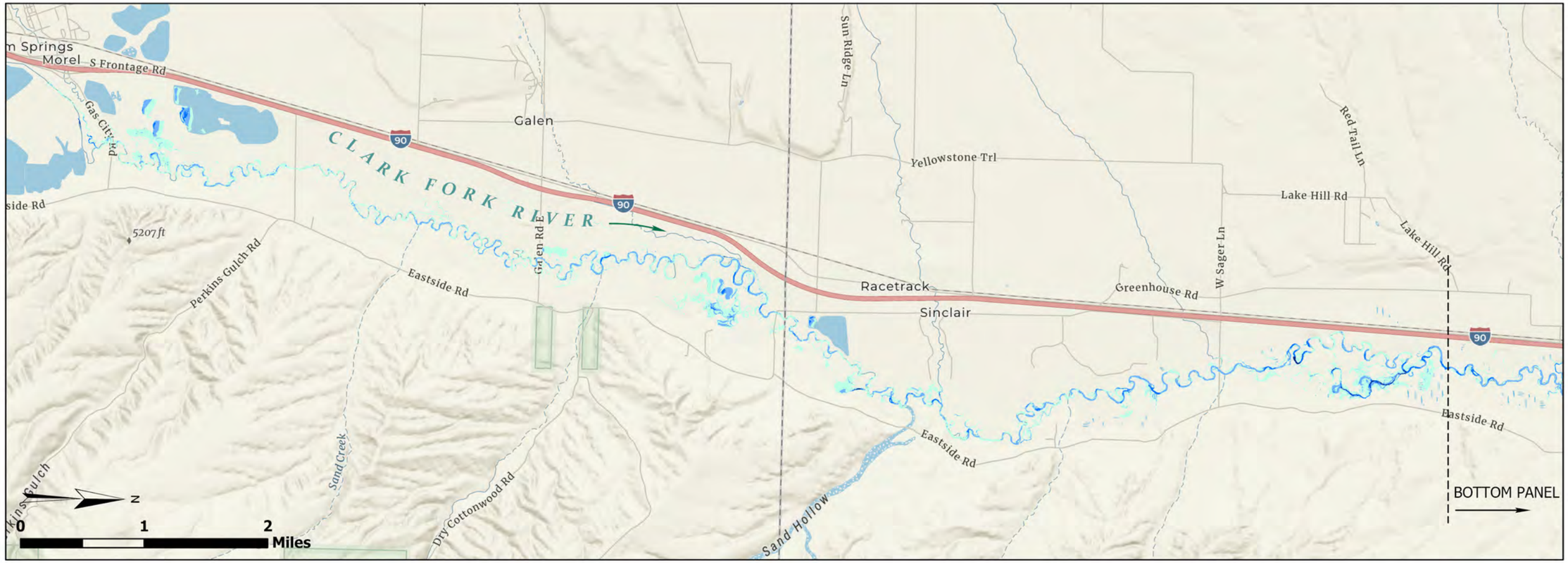
FEET

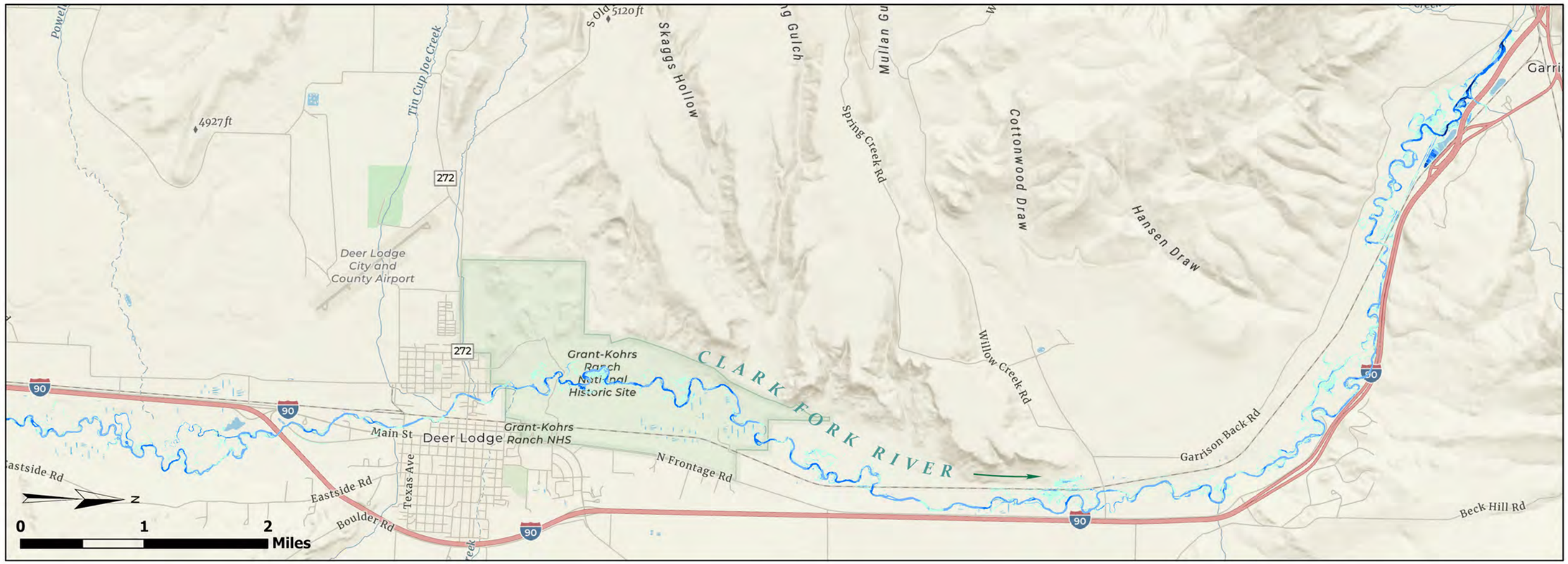
- ≤ 1
- ≤ 2
- ≤ 3
- ≤ 4
- ≤ 5
- ≤ 6

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

UPPER CLARK FORK RIVER
REACH A
HYDRAULIC MODEL OUTPUT





DEPTH Q2

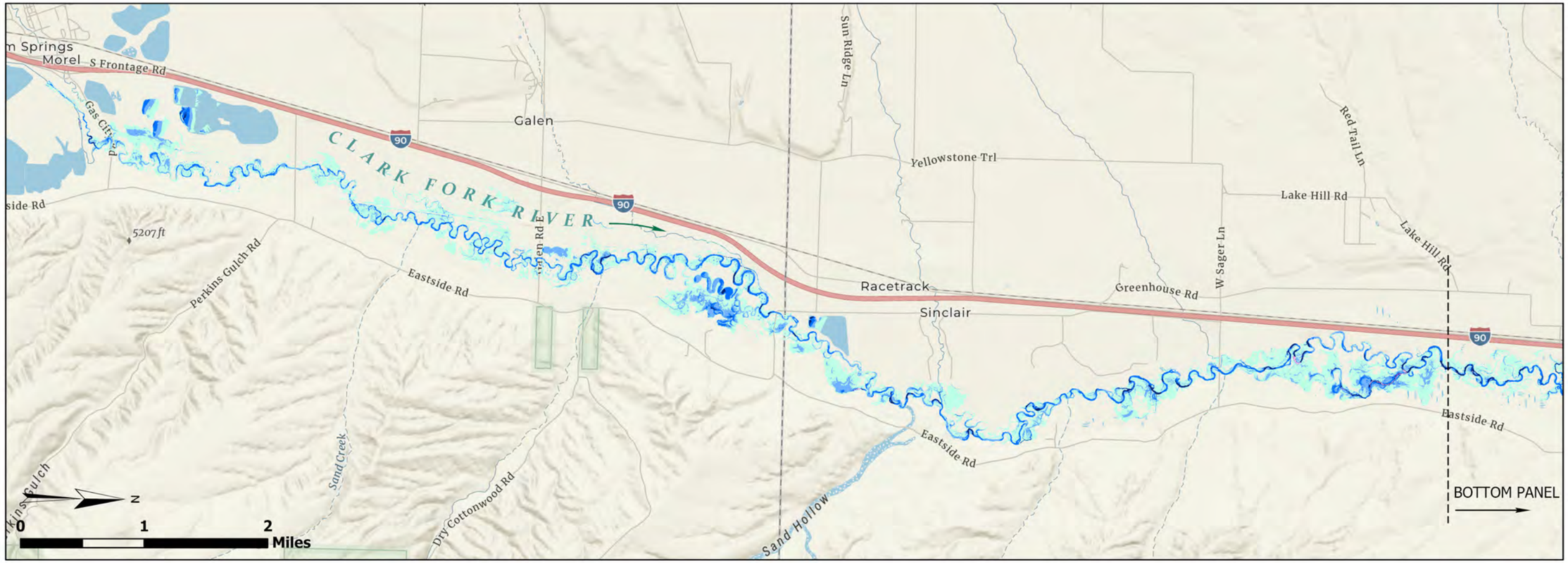
FEET

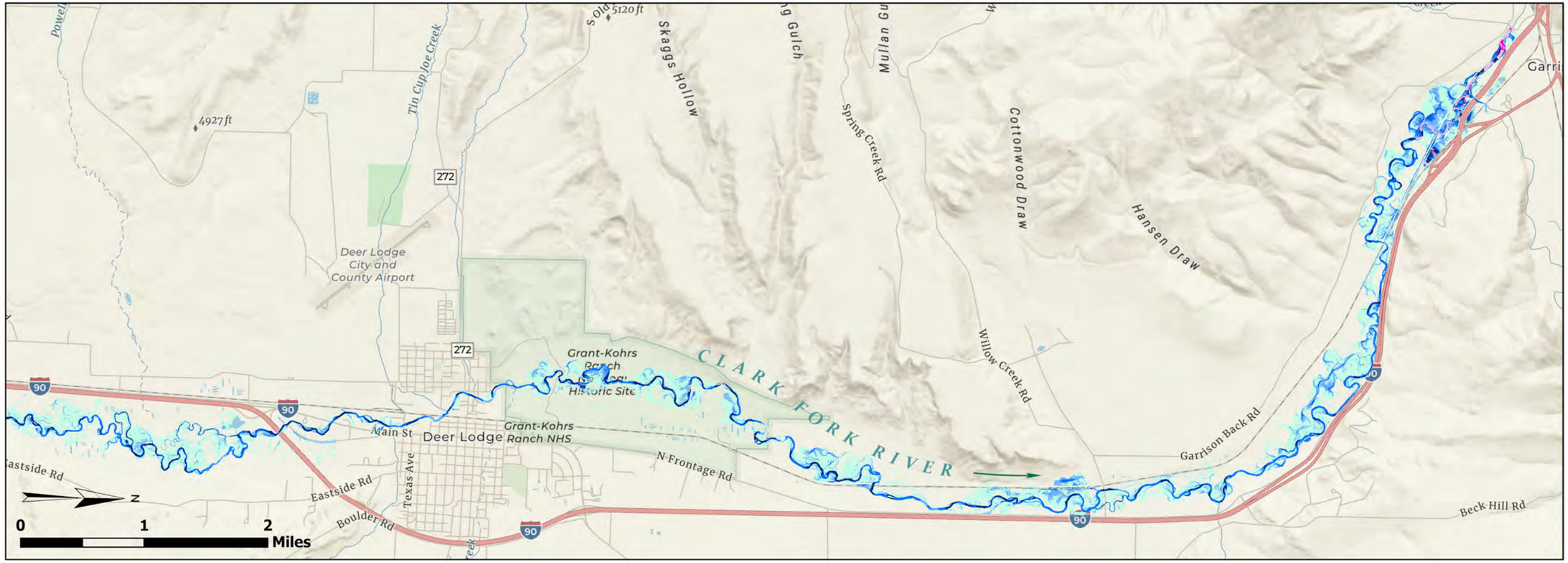
- ≤ 1
- ≤ 2
- ≤ 3
- ≤ 4
- ≤ 5
- ≤ 6

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

UPPER CLARK FORK RIVER
REACH A
HYDRAULIC MODEL OUTPUT





DEPTH Q10

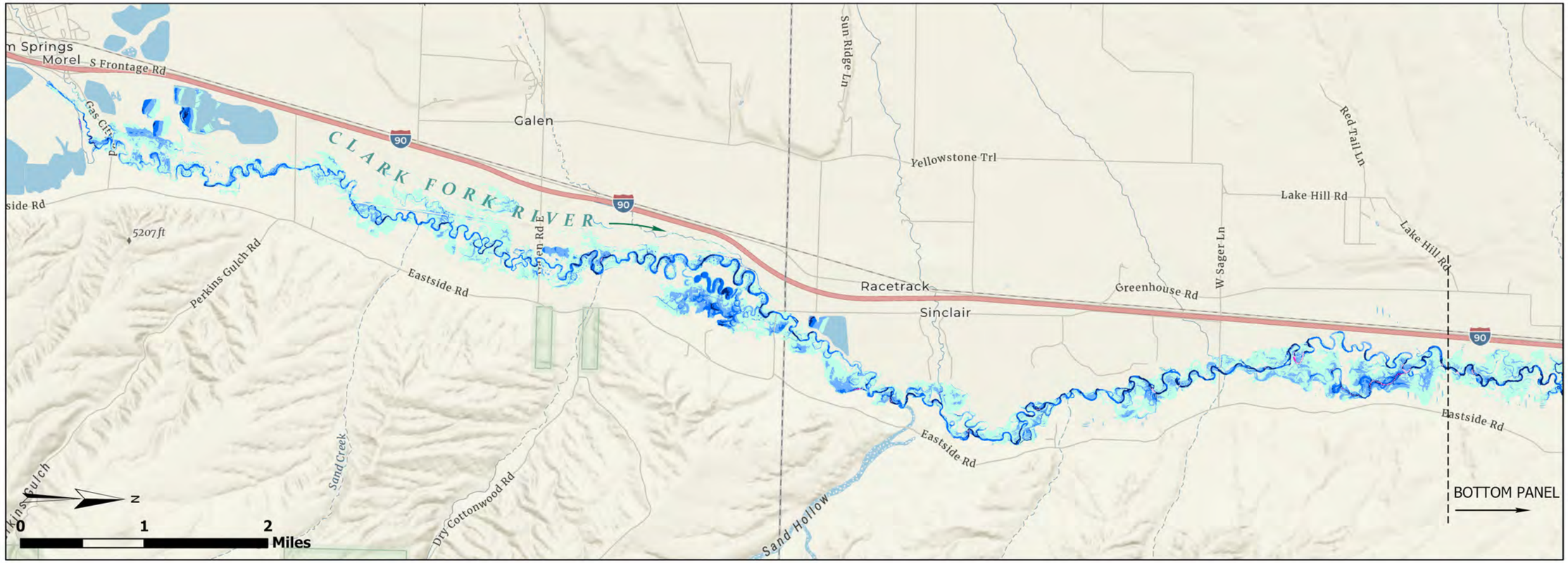
FEET

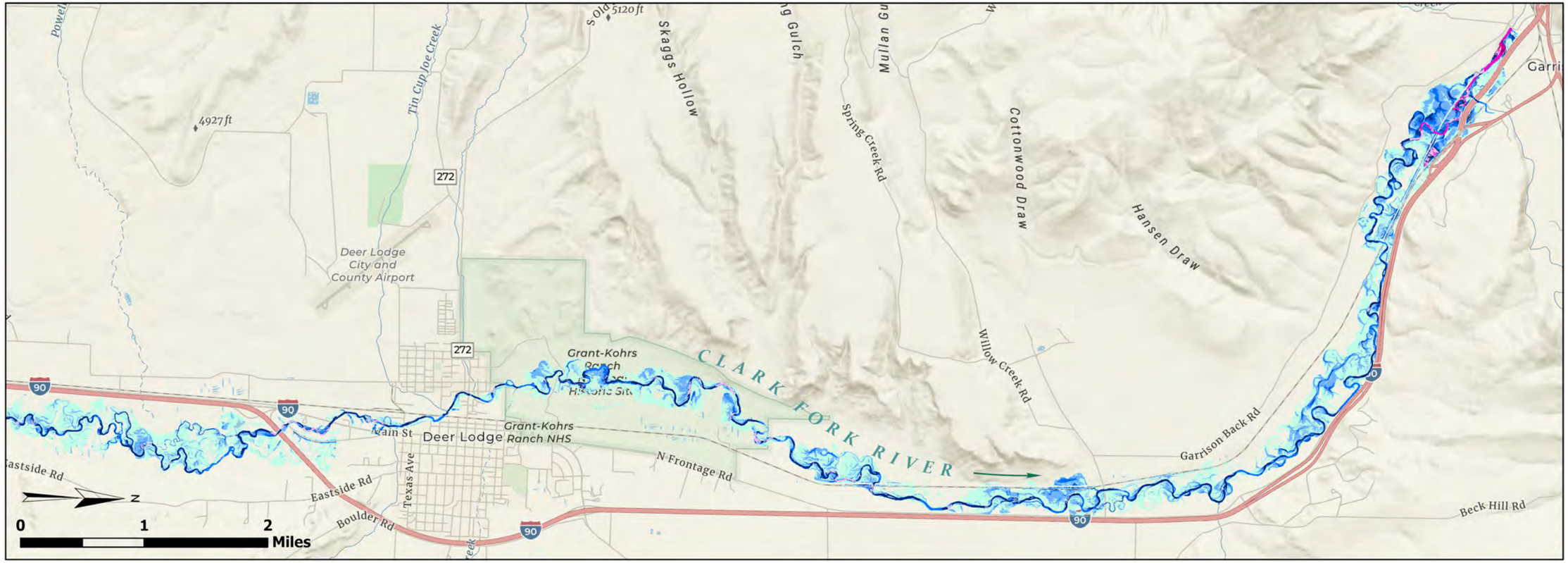
- ≤ 1
- ≤ 2
- ≤ 3
- ≤ 4
- ≤ 5
- ≤ 6
- ≤ 7

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

UPPER CLARK FORK RIVER
REACH A
HYDRAULIC MODEL OUTPUT





DEPTH Q25

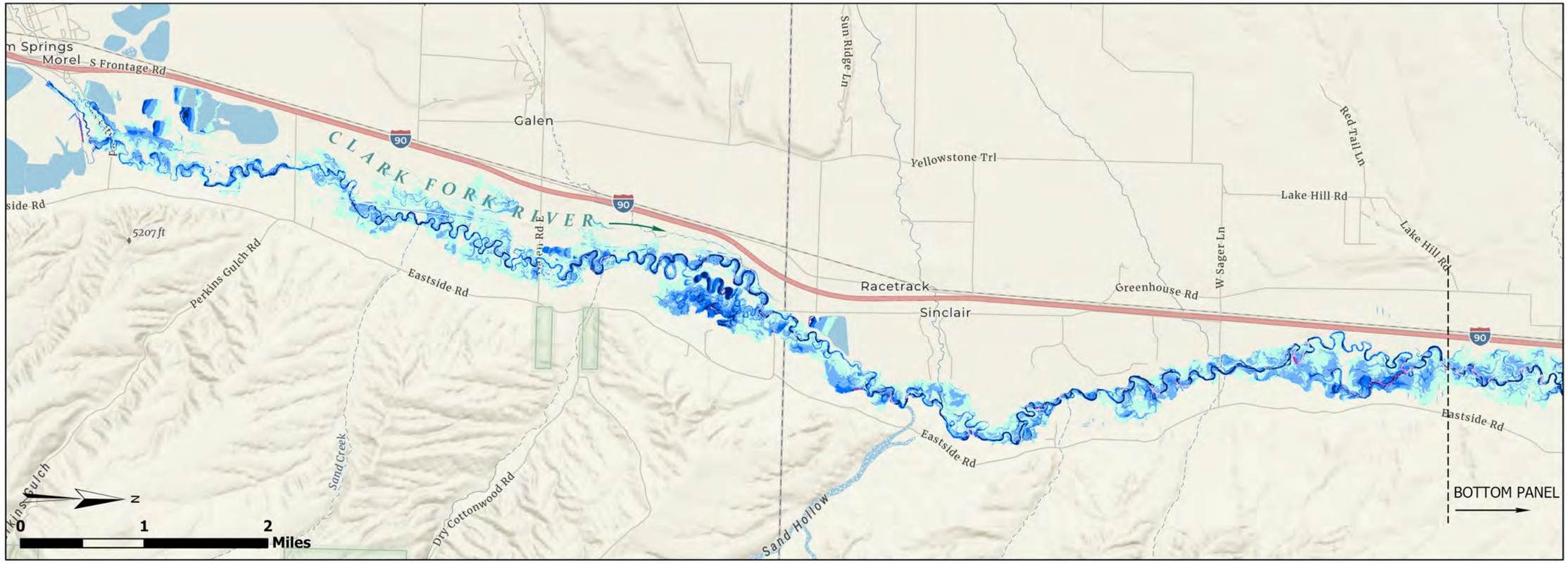
FEET

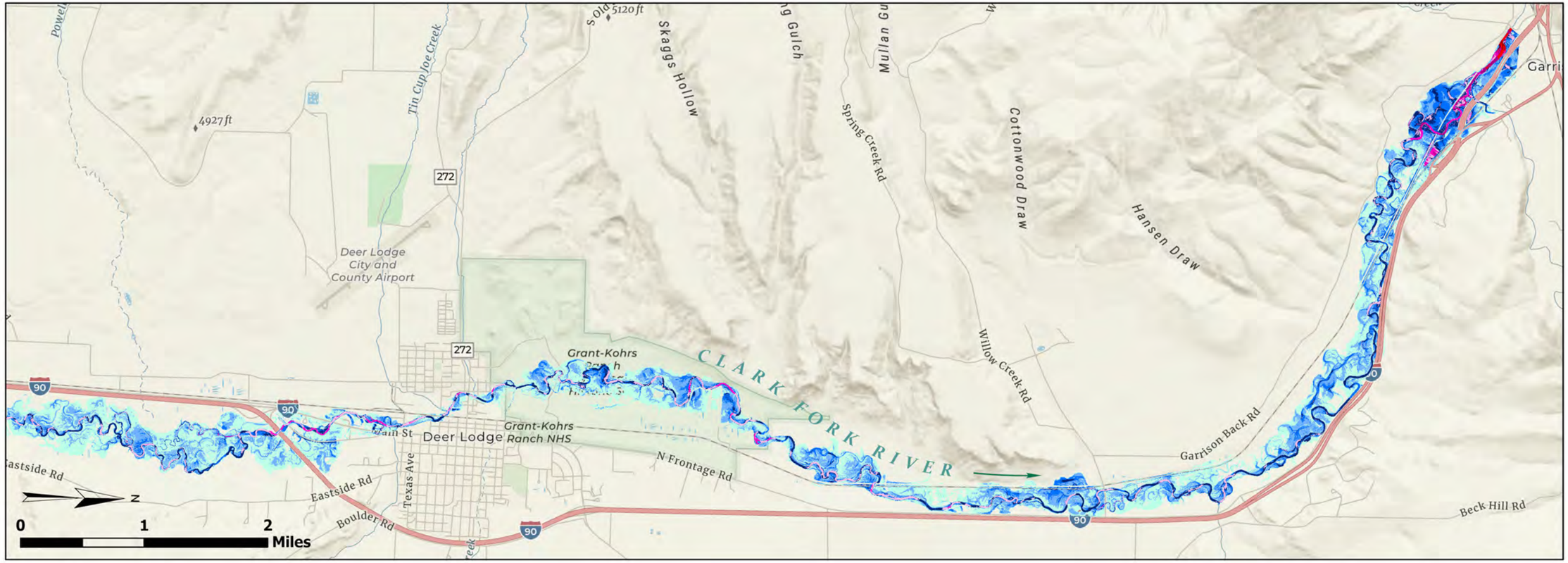
- ≤ 1
- ≤ 2
- ≤ 3
- ≤ 4
- ≤ 5
- ≤ 6
- ≤ 7
- ≤ 8
- ≤ 9

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

UPPER CLARK FORK RIVER
REACH A
HYDRAULIC MODEL OUTPUT





DEPTH Q100

FEET

- ≤ 1
- ≤ 2
- ≤ 3
- ≤ 4
- ≤ 5
- ≤ 6
- ≤ 7
- ≤ 8
- ≤ 9
- ≤ 10

RDG RIVER DESIGN GROUP

03.05.2021. RIVER DESIGN GROUP, INC.
BACKGROUND SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, OPENSTREETMAP.

Table C-1. Hydraulic model output for median bankfull indicator flow by reach (v04 p04 g04 f01)

Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude Chl.	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84 (mm)	d84 (ft)	Relative Roughness / d84	U/U*
1	246293	714	4806.04	4809.65	2.73	1.07	42.22	0.00	5.62	173.98	0.59	0.56	1.08	0.0297	63	0.21	13.19	8.67
1	245317	714	4803.40	4806.84	2.97	2.12	42.78	0.00	5.32	156.91	0.54	0.48	2.14	0.0293	63	0.21	14.37	8.88
1	244421	714	4799.31	4802.19	2.47	1.92	33.09	0.01	8.50	92.40	0.95	1.38	1.95	0.0302	63	0.21	11.94	8.43
1	242324	714	4789.44	4793.73	3.57	1.71	46.78	0.00	4.10	199.21	0.38	0.25	1.74	0.0286	63	0.21	17.27	9.33
1	238641	714	4783.67	4786.92	2.51	1.10	49.70	0.00	5.22	173.61	0.57	0.51	1.12	0.0301	63	0.21	12.13	8.47
1	237865	714	4782.02	4785.18	2.57	0.69	61.33	0.00	3.98	284.29	0.43	0.29	0.70	0.0300	63	0.21	12.44	8.53
1	234544	714	4776.82	4780.21	2.49	0.61	61.87	0.00	3.22	529.77	0.35	0.20	0.61	0.0302	63	0.21	12.04	8.45
1	232678	714	4772.58	4776.14	2.15	1.00	65.86	0.00	4.87	160.97	0.58	0.50	1.01	0.0311	63	0.21	10.40	8.09
1	231790	714	4770.49	4774.61	2.55	1.30	82.35	0.00	3.12	293.91	0.34	0.18	1.31	0.0301	63	0.21	12.34	8.51
1	229026	714	4765.82	4769.44	2.11	1.08	73.80	0.00	4.49	163.65	0.54	0.43	1.08	0.0312	63	0.21	10.23	8.05
1	228214	714	4763.56	4767.37	2.52	2.18	65.72	0.00	4.16	178.96	0.46	0.33	2.23	0.0301	63	0.21	12.18	8.48
1	225567	714	4758.33	4761.46	2.44	2.28	65.30	0.00	4.34	164.95	0.48	0.36	2.34	0.0303	63	0.21	11.80	8.40
1	224200	714	4753.33	4756.74	2.42	2.42	47.65	0.00	6.02	118.68	0.67	0.70	2.49	0.0303	63	0.21	11.73	8.38
1	224046	714	4752.31	4756.58	3.05	3.05	55.67	0.00	4.08	174.95	0.41	0.28	3.14	0.0292	63	0.21	14.75	8.95
2	223760	734	4752.54	4755.89	2.53	2.30	57.29	0.00	4.90	150.04	0.53	0.45	2.37	0.0301	63	0.21	12.22	8.48
2	222668	734	4749.15	4753.55	2.97	2.61	54.80	0.00	4.35	169.11	0.44	0.32	2.70	0.0293	63	0.21	14.35	8.88
2	221159	734	4746.09	4750.84	3.04	3.03	49.79	0.00	4.56	160.97	0.45	0.35	3.22	0.0292	63	0.21	14.70	8.94
2	220363	734	4745.67	4749.34	2.86	2.76	55.94	0.00	4.49	163.65	0.46	0.35	2.82	0.0295	63	0.21	13.82	8.79
2	220065	734	4745.09	4748.85	2.91	2.91	59.54	0.00	4.09	179.26	0.42	0.29	3.01	0.0294	63	0.21	14.06	8.83
2	219809	734	4744.55	4748.33	3.19	2.76	47.63	0.00	4.70	161.81	0.46	0.36	2.88	0.0290	63	0.21	15.42	9.06
2	217894	734	4741.75	4745.74	3.30	1.63	55.94	0.00	3.81	208.17	0.36	0.23	1.68	0.0289	63	0.21	15.97	9.14
2	216762	734	4739.92	4744.00	3.14	2.31	48.18	0.00	4.74	161.33	0.47	0.37	2.37	0.0291	63	0.21	15.22	9.02
2	214999	734	4736.46	4740.95	3.33	3.14	45.31	0.00	4.63	164.54	0.44	0.34	3.39	0.0288	63	0.21	16.12	9.16
2	214780	734	4736.75	4740.45	2.71	2.68	52.11	0.00	4.99	147.08	0.52	0.45	2.82	0.0297	63	0.21	13.13	8.66
2	214303	734	4735.08	4739.13	2.80	2.80	49.06	0.00	5.21	140.97	0.54	0.48	2.87	0.0296	63	0.21	13.53	8.73
2	213986	734	4733.31	4738.71	3.87	3.49	41.94	0.00	4.28	175.03	0.37	0.26	3.70	0.0282	63	0.21	18.74	9.53
2	213732	734	4733.57	4738.42	3.17	3.17	53.18	0.00	4.10	178.86	0.39	0.27	3.36	0.0290	63	0.21	15.33	9.04
2	213221	734	4734.10	4737.55	2.81	2.33	58.43	0.00	4.41	172.08	0.46	0.34	2.41	0.0295	63	0.21	13.61	8.75
2	212299	734	4731.80	4735.82	2.68	1.88	64.70	0.00	4.18	186.33	0.45	0.32	1.91	0.0298	63	0.21	12.95	8.62
2	211382	734	4730.21	4734.06	2.52	1.85	70.05	0.00	4.06	190.13	0.45	0.31	1.87	0.0301	63	0.21	12.20	8.48
2	210702	734	4728.90	4732.82	2.75	1.77	64.25	0.00	4.05	185.83	0.43	0.29	1.81	0.0297	63	0.21	13.29	8.69
2	210081	734	4727.81	4731.51	3.02	2.23	46.30	0.00	4.92	160.48	0.49	0.40	2.32	0.0292	63	0.21	14.63	8.92
2	209739	734	4728.02	4730.71	2.09	2.09	80.12	0.00	4.26	172.40	0.51	0.39	2.15	0.0313	63	0.21	10.12	8.02
2	209602	734	4726.50	4730.51	2.94	2.94	65.72	0.00	3.67	200.25	0.37	0.23	3.05	0.0294	63	0.21	14.22	8.85
2	208465	734	4724.40	4728.71	2.86	2.70	57.70	0.00	4.35	170.54	0.45	0.33	2.80	0.0295	63	0.21	13.84	8.79
2	208258	734	4724.70	4728.30	2.40	2.20	67.84	0.00	4.25	185.28	0.48	0.35	2.27	0.0304	63	0.21	11.61	8.36
2	208045	734	4723.96	4728.06	3.13	2.89	66.59	0.00	3.42	216.48	0.34	0.19	2.97	0.0291	63	0.21	15.14	9.01
2	207814	734	4724.53	4727.58	2.47	1.69	62.70	0.00	4.47	180.73	0.49	0.38	1.73	0.0302	63	0.21	11.94	8.43
2	206113	734	4721.02	4724.81	2.89	2.68	68.74	0.00	3.57	206.04	0.36	0.22	2.77	0.0294	63	0.21	13.98	8.81
2	204701	734	4718.97	4722.54	3.02	2.71	51.18	0.00	4.64	166.69	0.47	0.36	2.81	0.0293	63	0.21	14.62	8.92
2	204052	734	4717.87	4721.46	2.80	2.79	62.74	0.00	4.00	183.68	0.41	0.28	2.91	0.0296	63	0.21	13.55	8.74
2	202757	734	4715.15	4718.78	2.43	1.88	63.25	0.00	4.52	181.08	0.50	0.39	1.92	0.0303	63	0.21	11.76	8.39

Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude_num_Chl	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84_mm	d84_ft	Relative_rough_R_div_d84	U_div_Ustar
2	201851	734	4712.57	4717.12	3.23	2.21	52.68	0.00	4.20	187.13	0.41	0.28	2.28	0.0290	63	0.21	15.63	9.09
2	201768	734	4712.75	4716.84	2.65	2.40	47.06	0.00	5.20	164.13	0.56	0.49	2.48	0.0298	63	0.21	12.84	8.60
2	201555	734	4712.22	4716.30	2.36	2.22	66.96	0.00	4.43	166.23	0.50	0.39	2.31	0.0305	63	0.21	11.44	8.32
2	201281	734	4711.38	4715.81	3.40	1.87	44.05	0.00	4.37	203.24	0.42	0.30	1.92	0.0287	63	0.21	16.45	9.21
2	201199	734	4711.52	4715.45	2.41	2.16	50.96	0.00	5.44	149.06	0.62	0.57	2.26	0.0303	63	0.21	11.68	8.37
2	201126	734	4711.81	4715.39	2.82	1.78	56.57	0.00	4.20	207.95	0.44	0.31	1.81	0.0295	63	0.21	13.65	8.75
2	200777	734	4710.70	4714.66	2.69	1.20	56.61	0.00	4.52	196.69	0.48	0.37	1.21	0.0298	63	0.21	13.00	8.64
2	200391	734	4709.89	4714.06	2.63	0.67	70.06	0.00	3.59	289.43	0.38	0.24	0.68	0.0299	63	0.21	12.73	8.58
2	199743	734	4708.23	4713.09	3.17	0.65	50.66	0.00	4.12	280.97	0.40	0.28	0.65	0.0290	63	0.21	15.36	9.04
2	198331	734	4706.49	4711.09	3.07	1.32	54.27	0.00	4.08	235.20	0.41	0.28	1.33	0.0292	63	0.21	14.85	8.96
2	197736	734	4706.58	4710.40	2.69	1.20	78.57	0.00	3.23	282.66	0.34	0.19	1.21	0.0298	63	0.21	13.04	8.64
3	196629	831	4703.46	4708.87	3.16	2.38	59.47	0.00	4.21	221.55	0.42	0.29	2.45	0.0290	63	0.21	15.28	9.03
3	193602	831	4699.04	4703.97	3.27	2.41	49.07	0.00	4.74	197.84	0.46	0.36	2.52	0.0289	63	0.21	15.82	9.12
3	193497	831	4699.67	4703.87	2.34	1.84	93.97	0.00	3.67	242.61	0.42	0.27	1.87	0.0305	63	0.21	11.32	8.30
3	190697	831	4695.34	4699.19	2.64	1.78	81.98	0.00	3.71	247.86	0.40	0.25	1.80	0.0299	63	0.21	12.76	8.59
3	189389	831	4692.73	4697.13	3.22	2.70	55.94	0.00	4.33	217.55	0.42	0.30	2.76	0.0290	63	0.21	15.56	9.08
3	187949	831	4690.90	4694.19	2.33	1.84	71.14	0.00	4.57	216.60	0.53	0.42	1.87	0.0306	63	0.21	11.29	8.29
3	187054	831	4688.01	4692.07	2.68	2.63	69.39	0.00	4.32	192.54	0.46	0.34	2.73	0.0298	63	0.21	12.96	8.63
3	186048	831	4686.89	4690.39	3.05	2.85	60.88	0.00	4.08	235.23	0.41	0.28	2.90	0.0292	63	0.21	14.73	8.94
3	184897	831	4685.49	4688.86	2.69	2.10	79.49	0.00	3.47	291.92	0.37	0.22	2.16	0.0298	63	0.21	13.02	8.64
3	184069	831	4683.61	4687.76	2.37	1.54	99.32	0.00	3.24	307.31	0.37	0.21	1.56	0.0304	63	0.21	11.48	8.33
3	182891	831	4682.47	4686.33	2.56	1.94	105.77	0.00	3.04	284.62	0.34	0.17	1.96	0.0300	63	0.21	12.37	8.51
3	181728	831	4681.21	4684.55	2.65	1.53	71.59	0.00	4.20	233.24	0.45	0.32	1.55	0.0298	63	0.21	12.82	8.60
3	180675	831	4679.19	4682.76	2.38	1.99	95.89	0.00	3.48	248.93	0.39	0.24	2.05	0.0304	63	0.21	11.51	8.33
3	179922	831	4678.13	4681.19	2.52	1.28	68.96	0.00	4.49	234.10	0.50	0.38	1.29	0.0301	63	0.21	12.20	8.48
3	179012	831	4675.88	4679.77	2.66	2.51	92.54	0.00	3.32	250.92	0.36	0.20	2.54	0.0298	63	0.21	12.87	8.61
3	178881	831	4675.61	4679.61	2.57	2.41	95.42	0.00	3.34	249.47	0.37	0.21	2.43	0.0300	63	0.21	12.45	8.53
3	178012	831	4674.01	4678.33	3.08	2.69	64.36	0.00	4.09	207.88	0.41	0.28	2.76	0.0292	63	0.21	14.90	8.97
3	177561	831	4672.98	4677.12	3.07	1.16	37.28	0.00	6.12	199.73	0.61	0.62	1.17	0.0292	63	0.21	14.84	8.96
3	176655	831	4670.17	4675.24	3.59	2.69	44.53	0.00	4.89	176.47	0.44	0.36	2.83	0.0285	63	0.21	17.37	9.35
3	175584	831	4669.77	4673.68	3.12	1.16	59.41	0.00	4.16	267.32	0.41	0.28	1.18	0.0291	63	0.21	15.10	9.00
3	174998	831	4668.70	4672.36	2.87	2.65	52.33	0.00	5.31	168.81	0.55	0.49	2.69	0.0295	63	0.21	13.90	8.80
3	174290	831	4666.04	4670.41	3.38	1.73	41.26	0.00	5.80	157.88	0.55	0.53	1.76	0.0288	63	0.21	16.37	9.20
3	173291	831	4664.28	4668.76	2.76	0.92	68.83	0.00	3.80	348.50	0.40	0.25	0.92	0.0296	63	0.21	13.38	8.70
3	172598	831	4662.06	4665.62	2.06	2.06	48.31	0.01	8.19	101.47	1.00	1.47	2.10	0.0314	63	0.21	9.95	7.98
3	171880	831	4658.75	4664.49	2.78	0.84	48.31	0.00	3.16	778.59	0.32	0.18	0.84	0.0296	63	0.21	13.45	8.72
3	170548	831	4658.55	4660.31	1.45	1.28	83.85	0.02	6.81	124.00	1.00	1.39	1.29	0.0346	63	0.21	7.02	7.12
3	169785	831	4652.90	4657.91	3.82	2.87	42.92	0.00	4.80	189.68	0.43	0.33	3.08	0.0283	63	0.21	18.48	9.50
3	168633	831	4651.61	4656.21	3.18	1.26	51.28	0.00	4.49	273.84	0.44	0.33	1.28	0.0290	63	0.21	15.40	9.05
3	166791	831	4648.21	4651.86	2.64	2.53	57.55	0.00	5.43	153.82	0.59	0.54	2.59	0.0299	63	0.21	12.76	8.59
3	165108	831	4643.81	4648.19	3.05	0.72	60.61	0.00	4.33	252.25	0.44	0.31	0.73	0.0292	63	0.21	14.75	8.95
3	163384	831	4637.44	4642.53	2.24	2.13	52.08	0.01	6.95	120.00	0.81	0.99	2.18	0.0308	63	0.21	10.84	8.19
3	163153	831	4638.64	4642.16	2.78	2.20	70.46	0.00	4.11	213.04	0.43	0.30	2.24	0.0296	63	0.21	13.45	8.72

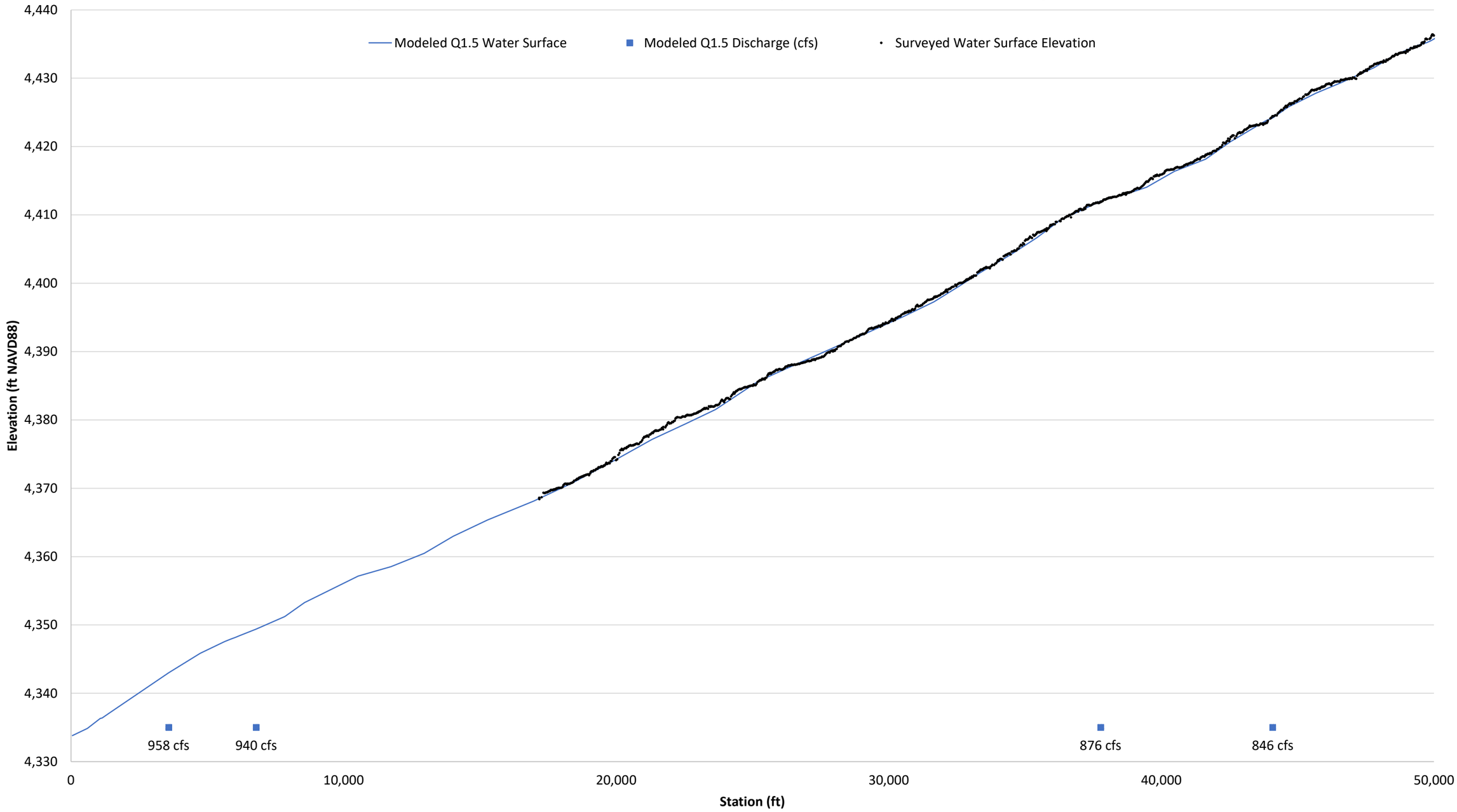
Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude_num_Chl	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84_mm	d84_ft	Relative_rough_R_div_d84	U_div_Ustar
3	163118	831	4637.94	4641.98	2.78	2.30	59.00	0.00	4.84	174.09	0.50	0.41	2.39	0.0296	63	0.21	13.43	8.72
3	162979	831	4636.59	4641.75	2.70	1.82	68.48	0.00	4.22	219.32	0.45	0.32	1.87	0.0298	63	0.21	13.06	8.65
3	161524	831	4633.75	4638.53	2.82	1.56	54.31	0.00	4.93	195.49	0.51	0.43	1.62	0.0296	63	0.21	13.62	8.75
3	160909	831	4631.97	4636.80	3.13	1.99	42.76	0.00	5.70	163.78	0.55	0.53	2.06	0.0291	63	0.21	15.17	9.01
3	159411	831	4628.67	4633.06	2.58	2.58	68.32	0.00	4.61	180.22	0.50	0.39	2.64	0.0300	63	0.21	12.50	8.54
3	157548	831	4625.69	4630.23	3.32	1.33	54.21	0.00	3.78	341.52	0.35	0.23	1.36	0.0288	63	0.21	16.06	9.16
3	155463	831	4623.33	4627.48	3.39	1.99	51.94	0.00	4.48	211.90	0.42	0.31	2.04	0.0287	63	0.21	16.42	9.21
3	153614	831	4620.43	4623.72	2.35	2.02	71.40	0.00	4.69	188.45	0.53	0.43	2.09	0.0305	63	0.21	11.38	8.31
3	152744	831	4616.16	4621.99	2.70	2.70	78.83	0.00	3.79	219.44	0.40	0.26	2.78	0.0298	63	0.21	13.09	8.65
4	151779	831	4616.95	4619.84	2.20	2.15	82.56	0.00	4.54	184.65	0.54	0.43	2.19	0.0309	63	0.21	10.65	8.15
4	151052	831	4615.06	4617.75	2.26	1.71	83.76	0.00	4.34	194.68	0.51	0.38	1.72	0.0308	63	0.21	10.95	8.21
4	149567	831	4610.80	4613.94	2.12	1.83	98.91	0.00	3.90	218.86	0.47	0.33	1.85	0.0312	63	0.21	10.24	8.05
4	149400	831	4610.06	4613.76	2.84	1.39	80.09	0.00	3.22	366.93	0.33	0.18	1.40	0.0295	63	0.21	13.76	8.78
4	149095	831	4608.41	4613.48	3.20	0.99	55.60	0.00	3.33	487.34	0.33	0.18	1.00	0.0290	63	0.21	15.50	9.07
4	147571	831	4604.90	4609.75	2.16	1.47	53.70	0.01	7.02	123.14	0.83	1.04	1.49	0.0310	63	0.21	10.43	8.09
4	147255	831	4605.92	4608.69	2.29	1.07	76.22	0.00	4.48	235.01	0.52	0.41	1.08	0.0307	63	0.21	11.07	8.24
4	145683	831	4601.19	4605.41	2.86	2.61	70.19	0.00	4.09	205.22	0.42	0.29	2.68	0.0295	63	0.21	13.86	8.79
4	144732	831	4599.50	4603.89	3.05	1.98	61.87	0.00	4.22	213.00	0.42	0.30	2.04	0.0292	63	0.21	14.77	8.95
4	142897	831	4595.98	4600.21	2.89	2.65	54.08	0.00	5.10	175.68	0.53	0.45	2.69	0.0294	63	0.21	13.98	8.81
4	141902	831	4593.48	4598.44	3.21	2.82	59.79	0.00	4.23	198.74	0.41	0.29	2.88	0.0290	63	0.21	15.51	9.07
5	141293	1095	4592.81	4597.60	3.29	2.11	77.76	0.00	4.18	279.12	0.40	0.28	2.15	0.0289	63	0.21	15.92	9.13
5	139652	1095	4590.52	4593.84	2.33	1.04	77.45	0.00	5.47	271.27	0.63	0.60	1.04	0.0306	63	0.21	11.28	8.29
5	138966	1095	4587.52	4591.64	2.85	1.98	68.70	0.00	5.19	258.21	0.54	0.47	2.03	0.0295	63	0.21	13.80	8.78
5	138112	1095	4585.77	4589.60	3.14	1.04	63.34	0.00	5.13	297.95	0.51	0.43	1.04	0.0291	63	0.21	15.20	9.02
5	138042	1095	4584.09	4589.58	2.28	0.95	120.85	0.00	3.74	384.42	0.44	0.28	0.96	0.0307	63	0.21	11.03	8.23
5	137214	1095	4584.02	4587.45	2.71	1.29	68.12	0.00	5.15	262.32	0.55	0.47	1.30	0.0297	63	0.21	13.10	8.65
5	136197	1095	4580.50	4585.29	3.51	1.03	57.95	0.00	4.88	300.08	0.45	0.36	1.04	0.0286	63	0.21	16.99	9.29
5	134575	1095	4578.44	4583.41	3.83	0.94	62.31	0.00	3.93	471.70	0.35	0.22	0.94	0.0283	63	0.21	18.51	9.50
5	133031	1095	4576.85	4579.39	1.95	1.12	71.16	0.01	7.31	182.83	0.92	1.22	1.13	0.0318	63	0.21	9.42	7.84
5	131685	1095	4572.83	4577.30	2.63	1.08	65.40	0.00	2.47	1254.58	0.26	0.11	1.09	0.0299	63	0.21	12.70	8.58
5	130822	1095	4573.57	4576.26	2.17	1.02	79.67	0.00	3.75	645.99	0.45	0.30	1.03	0.0310	63	0.21	10.48	8.10
5	129832	1095	4570.66	4573.59	2.26	0.96	77.94	0.00	4.62	428.83	0.54	0.44	0.96	0.0308	63	0.21	10.93	8.21
5	128809	1095	4568.88	4572.13	2.35	0.83	68.93	0.00	2.59	1121.50	0.30	0.13	0.84	0.0305	63	0.21	11.37	8.30
5	126972	1095	4567.13	4569.71	2.29	1.24	72.51	0.00	3.68	623.51	0.43	0.27	1.25	0.0307	63	0.21	11.10	8.25
5	124912	1095	4563.17	4566.81	3.08	1.02	60.01	0.00	3.56	742.65	0.35	0.21	1.03	0.0292	63	0.21	14.93	8.97
5	122586	1095	4559.68	4563.98	3.55	1.26	70.08	0.00	4.21	308.35	0.39	0.27	1.28	0.0286	63	0.21	17.19	9.32
5	121613	1095	4558.44	4563.26	3.61	0.66	77.37	0.00	3.09	899.12	0.28	0.14	0.66	0.0285	63	0.21	17.47	9.36
5	120800	1095	4559.35	4561.66	1.93	0.52	87.72	0.01	5.86	285.39	0.74	0.79	0.52	0.0319	63	0.21	9.36	7.83
5	120113	1095	4555.54	4559.00	1.88	1.79	150.75	0.00	3.71	307.95	0.47	0.32	1.81	0.0321	63	0.21	9.10	7.76
5	119232	1095	4552.50	4557.28	3.25	1.58	76.99	0.00	4.18	310.21	0.40	0.28	1.60	0.0289	63	0.21	15.72	9.10
5	119106	1095	4552.89	4557.18	3.09	2.05	90.30	0.00	3.57	351.71	0.35	0.21	2.12	0.0292	63	0.21	14.96	8.98
5	118560	1095	4552.25	4556.29	3.24	2.29	71.19	0.00	4.62	253.84	0.45	0.34	2.37	0.0290	63	0.21	15.68	9.10
5	117281	1095	4548.47	4553.72	2.93	1.05	66.68	0.00	5.02	274.87	0.51	0.43	1.07	0.0294	63	0.21	14.18	8.85

Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude_num_Chl	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84_mm	d84_ft	Relative_rough_R_div_d84	U_div_Ustar
5	116087	1095	4547.66	4551.23	3.00	2.13	77.76	0.00	4.59	260.32	0.47	0.35	2.15	0.0293	63	0.21	14.49	8.90
5	115427	1095	4545.76	4549.83	2.96	2.62	73.67	0.00	4.92	226.73	0.50	0.41	2.70	0.0293	63	0.21	14.32	8.87
5	114233	1095	4543.37	4548.11	3.56	3.48	73.50	0.00	4.02	272.73	0.37	0.24	3.62	0.0286	63	0.21	17.24	9.33
5	113174	1095	4543.05	4546.50	2.53	2.46	100.38	0.00	4.23	259.21	0.46	0.34	2.52	0.0301	63	0.21	12.25	8.49
5	112576	1095	4541.02	4546.06	3.43	2.51	116.61	0.00	2.68	442.40	0.25	0.11	2.55	0.0287	63	0.21	16.60	9.24
5	112040	1095	4541.02	4545.50	3.29	1.85	74.75	0.00	4.08	333.46	0.39	0.26	1.90	0.0289	63	0.21	15.94	9.14
5	109820	1095	4538.59	4542.49	3.25	1.10	75.00	0.00	4.21	328.13	0.41	0.28	1.12	0.0289	63	0.21	15.74	9.10
5	108902	1095	4536.44	4541.57	3.90	1.88	72.84	0.00	3.72	346.24	0.33	0.20	1.92	0.0282	63	0.21	18.85	9.55
5	106947	1095	4534.70	4539.32	3.45	1.40	63.74	0.00	4.63	282.32	0.43	0.33	1.43	0.0287	63	0.21	16.71	9.25
5	105957	1095	4533.65	4538.12	2.65	1.33	89.91	0.00	3.28	553.08	0.35	0.20	1.34	0.0298	63	0.21	12.84	8.60
5	104340	1095	4531.56	4535.46	2.88	1.41	69.85	0.00	4.66	346.08	0.48	0.37	1.43	0.0295	63	0.21	13.94	8.81
5	103547	1095	4529.33	4534.06	2.96	2.04	76.02	0.00	4.15	331.09	0.42	0.29	2.09	0.0293	63	0.21	14.34	8.88
5	102991	1095	4529.83	4533.13	2.35	1.08	78.60	0.00	3.89	546.51	0.44	0.30	1.09	0.0305	63	0.21	11.37	8.31
5	101374	1095	4527.36	4531.21	2.76	2.04	131.17	0.00	2.72	490.77	0.29	0.13	2.07	0.0297	63	0.21	13.33	8.70
5	100091	1095	4525.78	4529.59	2.77	1.68	91.12	0.00	4.19	277.94	0.44	0.31	1.71	0.0296	63	0.21	13.38	8.71
5	99123	1095	4523.59	4527.80	2.98	1.75	80.44	0.00	4.48	261.80	0.46	0.34	1.77	0.0293	63	0.21	14.43	8.89
5	98150	1095	4522.29	4525.96	3.12	2.93	72.66	0.00	4.73	235.08	0.47	0.37	2.98	0.0291	63	0.21	15.10	9.00
5	97570	1095	4520.68	4524.93	3.42	3.42	65.11	0.00	4.77	229.66	0.45	0.35	3.53	0.0287	63	0.21	16.53	9.23
5	95636	1095	4517.31	4522.66	3.85	1.95	68.17	0.00	3.93	327.11	0.35	0.22	2.03	0.0283	63	0.21	18.62	9.52
5	94516	1095	4517.82	4521.27	3.01	2.87	83.13	0.00	4.23	260.02	0.42	0.30	2.97	0.0293	63	0.21	14.57	8.92
5	94467	1095	4516.60	4521.11	3.36	2.49	66.12	0.00	4.77	234.88	0.45	0.36	2.56	0.0288	63	0.21	16.27	9.19
5	92798	1095	4514.53	4518.67	3.50	1.88	70.74	0.00	4.34	269.58	0.41	0.29	1.91	0.0286	63	0.21	16.95	9.29
5	92428	1095	4513.37	4518.14	3.50	2.77	66.88	0.00	4.49	248.54	0.42	0.31	2.86	0.0286	63	0.21	16.93	9.28
5	91438	1095	4513.38	4516.62	2.87	2.66	87.21	0.00	4.26	259.04	0.44	0.31	2.78	0.0295	63	0.21	13.90	8.80
5	91261	1095	4512.78	4516.29	3.16	3.00	74.63	0.00	4.48	253.14	0.44	0.33	3.11	0.0291	63	0.21	15.28	9.03
5	88461	1095	4505.89	4510.26	2.95	2.70	65.40	0.00	5.46	212.01	0.56	0.50	2.77	0.0293	63	0.21	14.30	8.87
5	88385	1095	4506.95	4509.61	2.25	2.11	65.09	0.01	7.07	168.00	0.82	1.02	2.15	0.0308	63	0.21	10.88	8.20
5	88196	1095	4505.35	4509.25	3.13	3.13	71.13	0.00	4.79	228.60	0.47	0.38	3.21	0.0291	63	0.21	15.13	9.01
5	86968	1095	4502.98	4506.54	2.52	2.19	89.21	0.00	4.67	254.02	0.52	0.41	2.27	0.0301	63	0.21	12.21	8.48
5	86314	1095	4500.98	4503.63	2.18	2.07	75.57	0.01	6.48	169.22	0.76	0.88	2.13	0.0310	63	0.21	10.53	8.12
5	85581	1095	4496.71	4501.38	3.22	3.08	62.45	0.00	5.04	242.14	0.49	0.41	3.14	0.0290	63	0.21	15.60	9.08
6	84831	1095	4496.54	4500.26	2.76	1.24	106.23	0.00	3.65	342.09	0.39	0.24	1.25	0.0297	63	0.21	13.33	8.70
6	84257	1095	4494.18	4499.16	3.07	2.20	73.74	0.00	4.76	235.56	0.48	0.38	2.23	0.0292	63	0.21	14.83	8.96
6	83243	1095	4492.71	4497.19	2.71	2.33	89.92	0.00	4.36	260.60	0.46	0.34	2.39	0.0297	63	0.21	13.12	8.66
6	82875	1095	4494.15	4496.56	2.13	2.14	98.72	0.00	3.51	394.54	0.42	0.26	2.18	0.0311	63	0.21	10.32	8.07
6	81672	1095	4490.00	4494.34	2.34	1.26	119.82	0.00	3.54	416.22	0.41	0.25	1.27	0.0305	63	0.21	11.33	8.30
6	79890	1095	4487.60	4491.17	2.27	0.97	123.75	0.00	3.59	420.76	0.42	0.26	0.97	0.0307	63	0.21	10.99	8.22
6	78985	1095	4485.99	4489.04	2.46	0.88	82.53	0.00	4.72	376.64	0.53	0.43	0.88	0.0303	63	0.21	11.91	8.42
6	78767	1095	4484.72	4488.58	2.38	1.07	85.40	0.00	4.04	484.63	0.45	0.32	1.09	0.0304	63	0.21	11.49	8.33
6	78149	1095	4483.81	4487.13	2.69	2.26	90.31	0.00	4.45	253.30	0.48	0.36	2.29	0.0298	63	0.21	13.01	8.64
6	77287	1095	4482.03	4485.34	2.58	2.16	98.79	0.00	4.24	263.88	0.46	0.33	2.18	0.0300	63	0.21	12.50	8.54
6	76245	1095	4479.23	4483.41	2.72	2.50	92.81	0.00	4.03	290.89	0.43	0.29	2.57	0.0297	63	0.21	13.18	8.67
6	75070	1095	4476.98	4481.78	3.29	2.19	82.51	0.00	3.88	300.86	0.37	0.24	2.23	0.0289	63	0.21	15.92	9.13

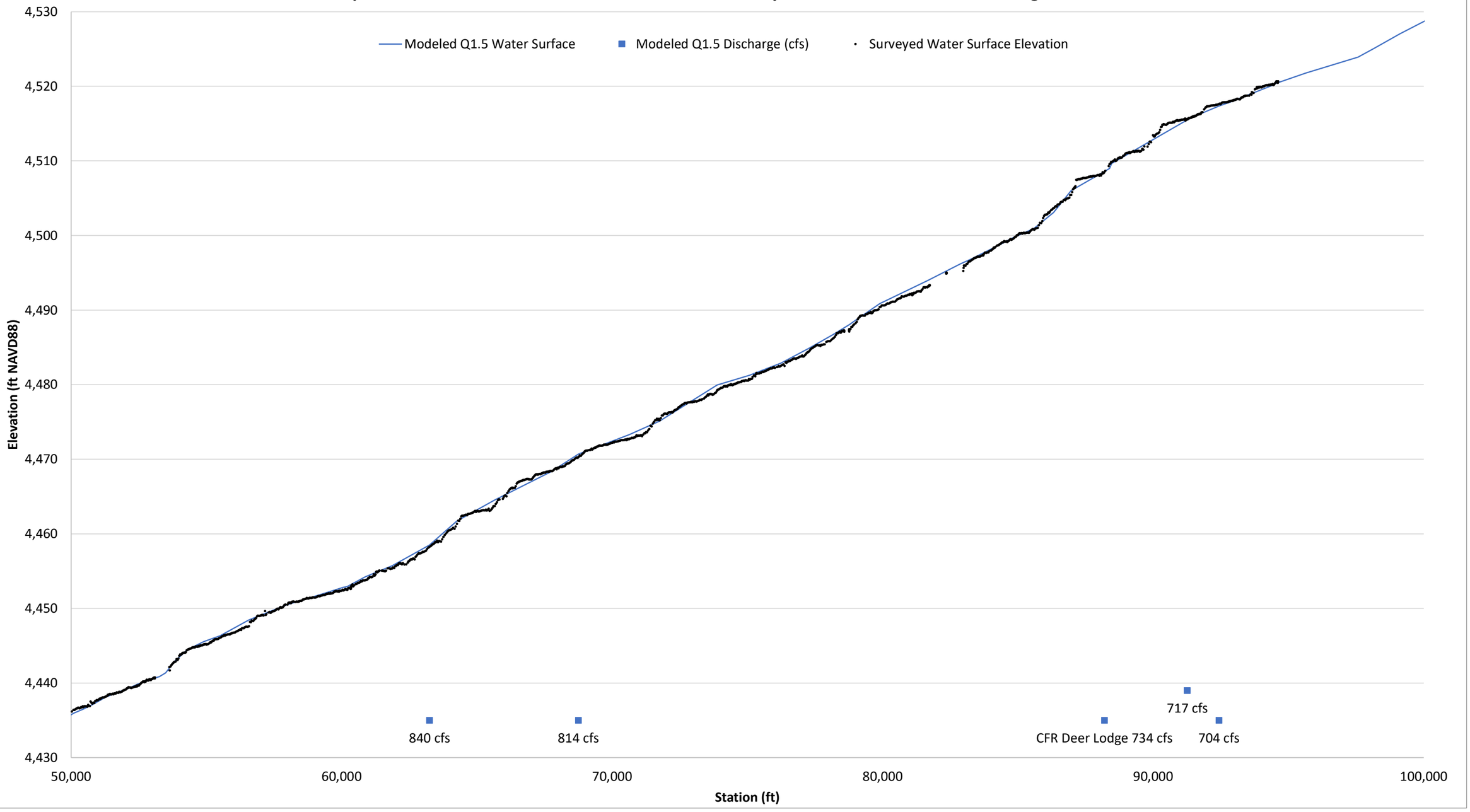
Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude_num_Chl	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84_mm	d84_ft	Relative_rough_R_div_d84	U_div_Ustar
6	73877	1095	4476.50	4480.46	3.34	0.96	83.42	0.00	3.77	365.44	0.36	0.22	0.97	0.0288	63	0.21	16.14	9.17
6	71747	1095	4471.55	4475.63	2.83	2.68	52.26	0.00	7.06	163.66	0.73	0.87	2.78	0.0295	63	0.21	13.70	8.76
6	70642	1095	4468.42	4474.00	3.51	3.12	82.71	0.00	3.69	308.44	0.34	0.21	3.28	0.0286	63	0.21	16.97	9.29
6	68753	1200	4467.15	4471.29	3.27	2.68	71.57	0.00	5.00	251.27	0.48	0.40	2.74	0.0289	63	0.21	15.80	9.11
6	67757	1200	4465.64	4468.98	2.84	2.07	78.62	0.00	5.25	242.88	0.55	0.48	2.09	0.0295	63	0.21	13.73	8.77
6	65652	1200	4460.96	4465.14	3.33	2.84	82.12	0.00	4.26	290.35	0.41	0.28	2.93	0.0288	63	0.21	16.12	9.16
6	64254	1200	4459.02	4462.20	2.56	2.48	88.86	0.00	5.21	232.46	0.57	0.51	2.52	0.0301	63	0.21	12.37	8.51
7	63252	1242	4455.66	4459.25	2.62	2.19	93.72	0.00	4.98	253.13	0.54	0.45	2.22	0.0299	63	0.21	12.69	8.58
7	61866	1242	4451.94	4456.37	3.68	1.40	63.92	0.00	5.02	293.78	0.45	0.37	1.43	0.0284	63	0.21	17.82	9.41
7	60869	1242	4450.37	4454.98	3.24	1.39	85.12	0.00	4.14	409.82	0.40	0.27	1.41	0.0289	63	0.21	15.65	9.09
7	60190	1242	4449.49	4453.74	3.42	2.32	69.88	0.00	5.10	255.03	0.48	0.40	2.38	0.0287	63	0.21	16.55	9.23
7	60074	1242	4448.92	4453.67	3.73	2.85	75.91	0.00	4.12	306.47	0.37	0.25	2.99	0.0284	63	0.21	18.06	9.44
7	59273	1242	4447.68	4452.59	3.34	2.01	74.48	0.00	4.58	306.35	0.44	0.33	2.07	0.0288	63	0.21	16.17	9.17
7	57962	1242	4447.19	4451.13	2.84	2.60	137.43	0.00	3.10	417.37	0.32	0.17	2.64	0.0295	63	0.21	13.72	8.77
7	56569	1242	4445.35	4448.99	3.08	2.70	80.68	0.00	4.92	261.72	0.49	0.40	2.76	0.0292	63	0.21	14.88	8.97
7	55506	1242	4443.39	4447.02	2.71	2.65	111.11	0.00	4.09	304.88	0.44	0.30	2.72	0.0297	63	0.21	13.10	8.65
7	54915	1242	4441.73	4446.19	3.81	3.11	75.56	0.00	4.25	308.41	0.38	0.26	3.23	0.0283	63	0.21	18.43	9.49
7	54298	1242	4442.14	4445.06	2.49	2.49	100.48	0.00	4.84	256.75	0.53	0.44	2.56	0.0302	63	0.21	12.07	8.45
7	53916	1242	4440.57	4443.64	2.46	2.41	88.48	0.00	5.64	220.80	0.63	0.61	2.47	0.0303	63	0.21	11.89	8.41
7	53838	1242	4440.59	4443.40	2.34	2.31	102.35	0.00	5.12	242.64	0.59	0.52	2.36	0.0306	63	0.21	11.32	8.30
7	53491	1242	4438.95	4442.10	2.33	2.22	97.34	0.00	5.26	236.90	0.60	0.55	2.41	0.0306	63	0.21	11.27	8.28
7	53258	1242	4437.40	4441.61	3.54	3.15	71.47	0.00	4.77	270.59	0.44	0.35	3.26	0.0286	63	0.21	17.12	9.31
7	53005	1242	4435.59	4441.30	4.14	3.71	63.02	0.00	4.59	275.34	0.39	0.29	3.83	0.0280	63	0.21	20.05	9.70
7	52467	1242	4436.58	4440.57	2.96	2.83	93.77	0.00	4.37	286.31	0.44	0.32	2.89	0.0293	63	0.21	14.32	8.87
7	52161	1242	4435.83	4440.12	3.13	2.69	94.81	0.00	4.11	314.50	0.41	0.28	2.75	0.0291	63	0.21	15.12	9.01
7	51277	1242	4433.45	4438.85	3.89	1.58	65.10	0.00	4.69	323.89	0.42	0.31	1.61	0.0282	63	0.21	18.83	9.55
7	50805	1242	4433.07	4437.83	2.78	1.60	79.74	0.00	5.42	247.84	0.57	0.52	1.63	0.0296	63	0.21	13.44	8.72
7	50472	1242	4432.32	4437.31	3.02	1.90	95.45	0.00	4.01	356.61	0.40	0.27	1.97	0.0292	63	0.21	14.60	8.92
7	50095	1242	4431.51	4436.79	3.61	1.82	66.48	0.00	4.35	458.80	0.40	0.28	1.85	0.0285	63	0.21	17.46	9.36
7	49876	1242	4432.03	4436.40	3.00	1.52	75.31	0.00	4.74	379.79	0.48	0.38	1.54	0.0293	63	0.21	14.53	8.91
7	49724	1242	4430.47	4435.96	4.01	2.54	55.17	0.00	5.40	236.81	0.47	0.41	2.60	0.0281	63	0.21	19.40	9.62
7	49379	1242	4430.60	4435.48	3.59	2.40	67.40	0.00	4.80	295.23	0.44	0.35	2.48	0.0285	63	0.21	17.39	9.35
7	48544	1242	4430.59	4433.95	2.67	1.18	86.64	0.00	4.63	390.72	0.49	0.39	1.20	0.0298	63	0.21	12.92	8.62
7	47811	1242	4428.69	4432.18	2.75	0.95	83.43	0.00	4.84	374.73	0.51	0.42	0.96	0.0297	63	0.21	13.32	8.69
7	46596	1242	4425.69	4430.22	3.58	2.19	77.16	0.00	4.23	339.01	0.39	0.27	2.24	0.0285	63	0.21	17.32	9.34
7	45662	1242	4423.01	4428.55	3.49	1.80	62.73	0.00	5.47	241.29	0.51	0.46	1.84	0.0286	63	0.21	16.89	9.28
7	44654	1242	4422.79	4426.33	2.78	1.28	71.85	0.00	4.96	373.36	0.52	0.43	1.30	0.0296	63	0.21	13.45	8.72
7	44086	1242	4421.45	4424.81	2.86	2.21	79.28	0.00	5.15	277.91	0.53	0.46	2.25	0.0295	63	0.21	13.83	8.79
7	43835	1242	4419.85	4424.39	3.38	2.69	75.84	0.00	4.53	318.46	0.43	0.32	2.77	0.0288	63	0.21	16.36	9.20
7	42530	1242	4418.07	4421.22	2.42	2.30	92.23	0.00	5.49	227.14	0.62	0.58	2.34	0.0303	63	0.21	11.71	8.38
7	41618	1242	4414.40	4418.91	3.31	3.02	73.20	0.00	4.94	256.41	0.47	0.39	3.12	0.0289	63	0.21	16.01	9.15
7	40484	1242	4412.15	4417.13	3.88	3.37	64.70	0.00	4.80	270.25	0.43	0.33	3.49	0.0282	63	0.21	18.76	9.54
7	39453	1242	4410.62	4414.69	2.94	2.80	64.72	0.00	6.29	209.32	0.64	0.67	2.86	0.0294	63	0.21	14.24	8.86

Model reach	River Sta	Q Total	Min Ch El	WS Elev	Hydr Radius C	Hydr Radius	Top W Act Chan	E.G. Slope	Vel Chnl	Flow Area	Froude_num_Chl	Shear Chan	Hydr Depth	Mann Wtd Chnl	d84_mm	d84_ft	Relative_rough_R_div_d84	U_div_Ustar
7	38799	1242	4409.36	4413.74	3.55	2.49	84.00	0.00	3.99	319.36	0.37	0.24	2.57	0.0286	63	0.21	17.19	9.32
7	38657	1242	4409.56	4413.53	3.16	2.26	89.64	0.00	4.22	306.98	0.41	0.29	2.34	0.0290	63	0.21	15.29	9.03
7	38578	1242	4409.48	4413.43	3.37	2.30	86.68	0.00	4.16	314.88	0.40	0.27	2.34	0.0288	63	0.21	16.31	9.19
7	38443	1242	4408.87	4413.26	3.45	1.74	81.58	0.00	4.20	361.39	0.40	0.27	1.77	0.0287	63	0.21	16.67	9.25
7	38110	1242	4407.53	4412.77	3.61	1.98	73.40	0.00	4.49	304.09	0.41	0.30	2.02	0.0285	63	0.21	17.46	9.36
8	37773	1121	4407.74	4412.34	2.98	1.17	82.88	0.00	4.11	363.47	0.42	0.29	1.18	0.0293	63	0.21	14.43	8.89
8	36286	1121	4404.49	4409.51	2.46	1.29	100.83	0.00	4.34	296.32	0.48	0.36	1.31	0.0303	63	0.21	11.91	8.42
8	35431	1121	4403.05	4407.00	2.71	2.71	75.07	0.00	5.45	205.82	0.58	0.53	2.74	0.0297	63	0.21	13.11	8.66
8	34482	1121	4400.94	4404.49	2.92	2.86	74.59	0.00	5.01	224.58	0.51	0.43	2.95	0.0294	63	0.21	14.15	8.84
8	33362	1121	4398.06	4401.91	2.89	1.88	76.32	0.00	4.91	247.94	0.50	0.41	1.92	0.0294	63	0.21	13.98	8.81
8	32553	1121	4395.51	4399.91	2.88	1.73	71.04	0.00	5.19	258.41	0.54	0.47	1.76	0.0295	63	0.21	13.96	8.81
8	31651	1121	4392.43	4397.74	2.63	1.90	89.92	0.00	4.60	252.61	0.49	0.39	1.94	0.0299	63	0.21	12.73	8.58
8	30508	1121	4390.77	4395.45	3.68	3.08	57.33	0.00	5.02	225.21	0.45	0.37	3.24	0.0284	63	0.21	17.79	9.41
8	30012	1121	4389.47	4394.55	3.02	1.90	73.07	0.00	4.93	248.68	0.50	0.41	1.98	0.0292	63	0.21	14.61	8.92
8	28829	1121	4388.18	4392.41	3.05	1.39	80.29	0.00	4.31	318.40	0.43	0.31	1.40	0.0292	63	0.21	14.77	8.95
8	28237	1121	4387.50	4391.35	2.62	1.59	99.08	0.00	4.20	302.46	0.46	0.32	1.60	0.0299	63	0.21	12.66	8.57
8	26180	1121	4382.98	4387.71	3.11	1.35	78.17	0.00	4.33	312.53	0.43	0.31	1.38	0.0291	63	0.21	15.03	8.99
8	25207	1121	4381.67	4385.98	3.05	1.08	74.69	0.00	4.64	295.02	0.46	0.36	1.09	0.0292	63	0.21	14.76	8.95
8	23644	1121	4377.85	4381.88	2.92	2.06	61.34	0.00	5.99	203.71	0.61	0.61	2.10	0.0294	63	0.21	14.13	8.84
8	22570	1121	4374.49	4379.81	3.20	1.62	77.01	0.00	4.23	331.76	0.41	0.29	1.64	0.0290	63	0.21	15.46	9.06
8	21315	1121	4372.95	4377.53	3.02	1.94	72.92	0.00	4.86	249.90	0.48	0.40	1.99	0.0293	63	0.21	14.61	8.92
8	19994	1121	4370.37	4374.61	3.34	2.90	57.85	0.00	5.41	224.27	0.51	0.46	3.04	0.0288	63	0.21	16.15	9.17
8	18365	1121	4367.19	4371.05	2.92	2.29	75.78	0.00	4.89	235.65	0.50	0.41	2.35	0.0294	63	0.21	14.13	8.84
8	16965	1121	4364.42	4368.45	3.00	1.24	81.67	0.00	4.27	333.95	0.43	0.31	1.25	0.0293	63	0.21	14.51	8.90
8	15286	1121	4359.92	4365.59	2.72	1.39	97.31	0.00	4.11	301.09	0.43	0.30	1.40	0.0297	63	0.21	13.14	8.66
8	14012	1121	4359.44	4363.30	2.82	1.32	80.68	0.00	4.28	386.68	0.44	0.32	1.33	0.0296	63	0.21	13.62	8.75
8	12955	1121	4355.55	4360.88	3.21	3.12	63.25	0.00	5.46	206.38	0.53	0.48	3.20	0.0290	63	0.21	15.52	9.07
8	11742	1121	4353.52	4358.87	4.47	1.63	45.18	0.00	5.15	312.21	0.43	0.35	1.67	0.0278	63	0.21	21.61	9.88
8	10527	1121	4353.13	4357.42	3.18	1.45	83.18	0.00	4.00	353.55	0.39	0.26	1.46	0.0290	63	0.21	15.40	9.05
8	8564	1121	4350.36	4353.55	2.51	2.30	82.88	0.00	4.98	251.78	0.55	0.47	2.37	0.0301	63	0.21	12.13	8.47
8	7846	1121	4347.86	4351.56	2.77	2.21	75.10	0.00	5.02	260.93	0.53	0.44	2.23	0.0296	63	0.21	13.40	8.71
8	6791	1121	4345.31	4349.74	3.72	3.21	64.68	0.00	4.51	272.18	0.41	0.30	3.27	0.0284	63	0.21	18.02	9.44
9	6166	1121	4344.48	4348.79	3.29	3.17	71.20	0.00	4.69	247.14	0.45	0.35	3.29	0.0289	63	0.21	15.93	9.13
9	6028	1121	4343.78	4348.58	3.22	2.74	73.95	0.00	4.50	265.60	0.44	0.33	2.82	0.0290	63	0.21	15.57	9.08
9	5855	1121	4343.67	4348.35	3.61	2.77	70.09	0.00	4.30	272.49	0.39	0.28	2.89	0.0285	63	0.21	17.48	9.36
9	5633	1121	4343.00	4348.01	3.61	3.23	65.25	0.00	4.61	247.84	0.42	0.32	3.32	0.0285	63	0.21	17.48	9.36
9	4738	1121	4342.58	4345.33	2.05	2.05	86.26	0.01	6.23	180.01	0.76	0.86	2.09	0.0315	63	0.21	9.90	7.97
9	3582	1121	4336.86	4341.53	3.00	2.77	74.03	0.00	4.83	249.09	0.49	0.39	2.81	0.0293	63	0.21	14.52	8.91
9	1425	1121	4332.64	4336.21	2.11	2.03	122.32	0.00	4.30	263.36	0.52	0.40	2.11	0.0312	63	0.21	10.23	8.05
9	1140	1121	4331.72	4335.28	1.84	1.83	131.04	0.00	4.20	297.39	0.55	0.43	1.86	0.0323	63	0.21	8.91	7.71
9	1073	1121	4331.63	4335.08	1.60	1.57	154.98	0.00	3.73	346.15	0.52	0.38	1.59	0.0336	63	0.21	7.73	7.36
9	602	1121	4329.12	4333.67	3.16	2.92	72.84	0.00	4.79	240.25	0.47	0.37	2.96	0.0290	63	0.21	15.29	9.03
9	34	1121	4328.98	4332.63	2.56	2.49	103.21	0.00	4.15	277.24	0.45	0.32	2.53	0.0300	63	0.21	12.40	8.52

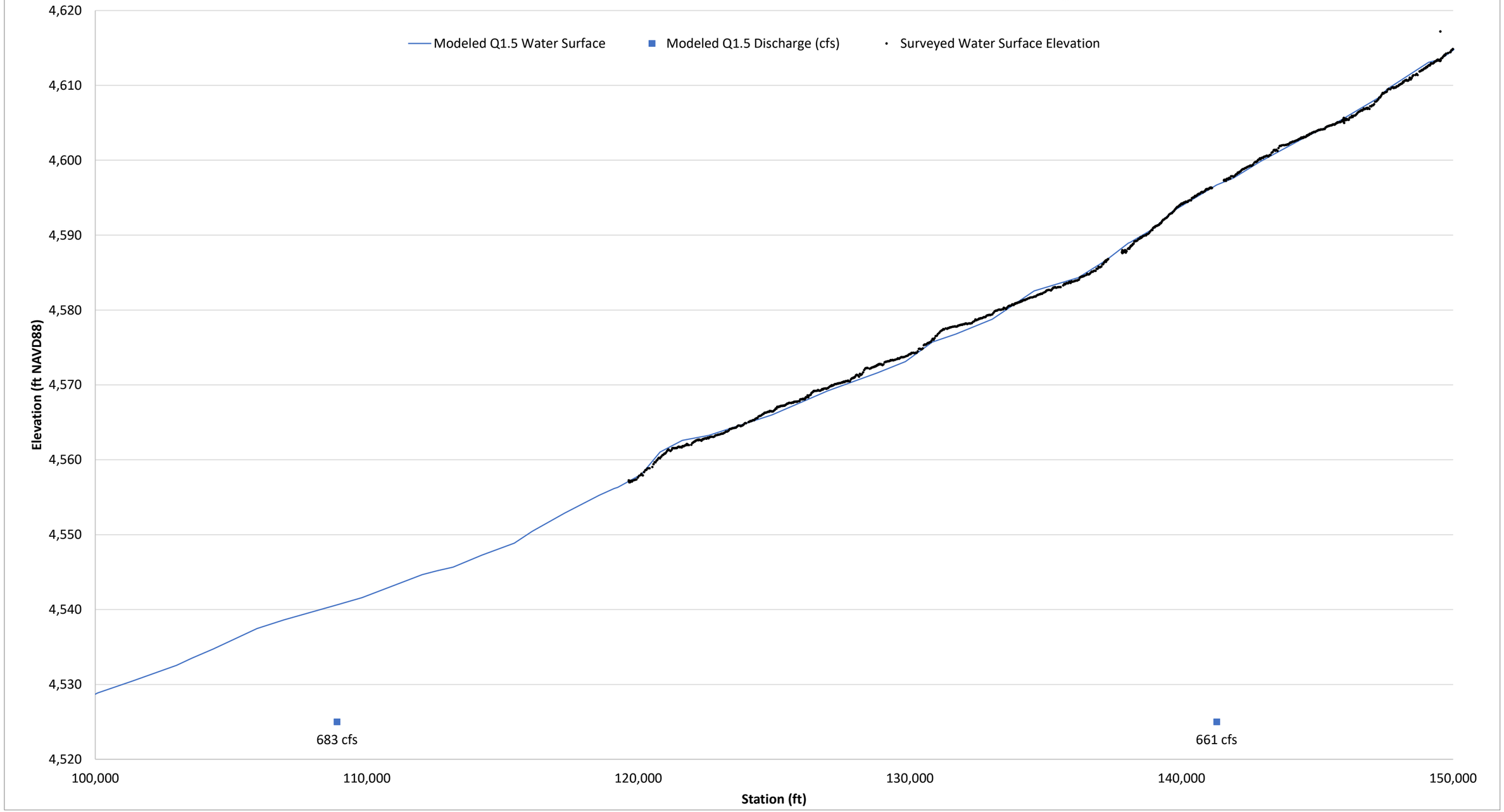
Comparison of Near-Bankfull Water Surface Profile Survey with Modeled 1.5-Year Discharge Elevation



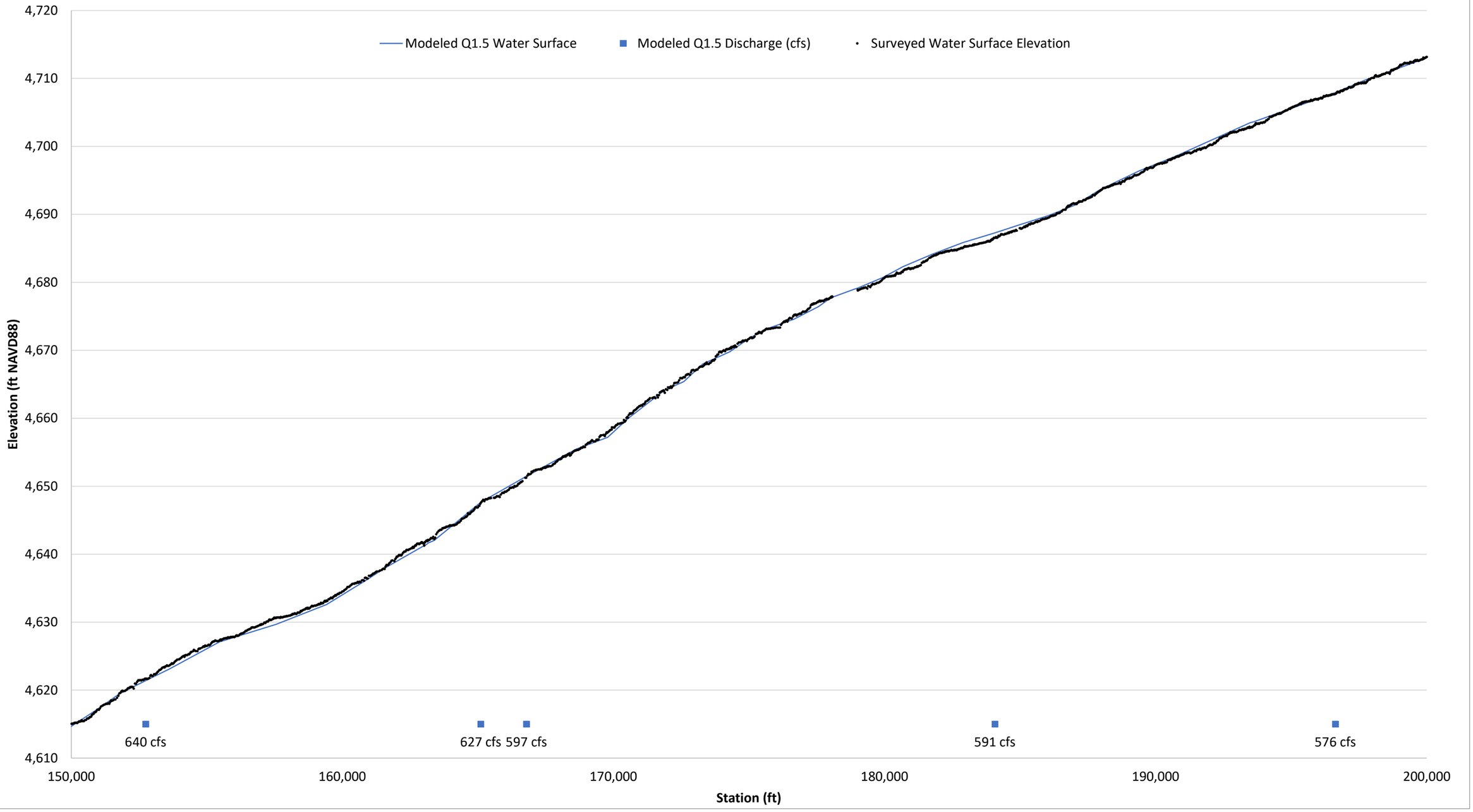
Comparison of Near-Bankfull Water Surface Profile Survey with Modeled 1.5-Year Discharge Elevation



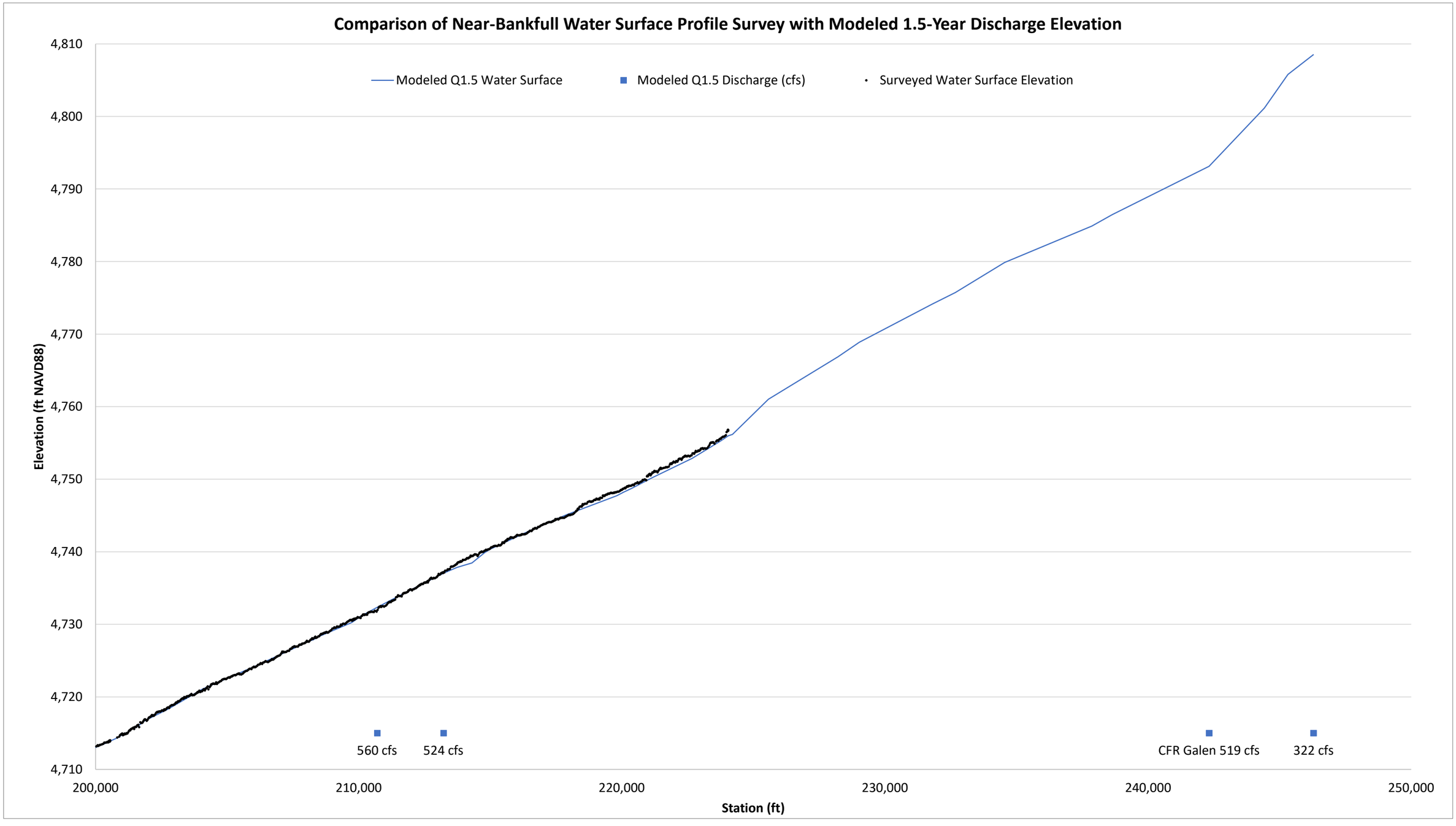
Comparison of Near-Bankfull Water Surface Profile Survey with Modeled 1.5-Year Discharge Elevation



Comparison of Near-Bankfull Water Surface Profile Survey with Modeled 1.5-Year Discharge Elevation



Comparison of Near-Bankfull Water Surface Profile Survey with Modeled 1.5-Year Discharge Elevation



APPENDIX D – BANKFULL INDICATOR DATA

Table D-1. Bankfull analysis data.

Station (ft)	WSEL (ft NAVD88)	Description	Flow (cfs)	RI (yrs)	FD (%)	Upstream River Station (ft)	Model Reach	CFROU Phase
3,584	4343.04	BF_GD	1,786	1.27	3.74%	6,791	1	--
4,737	4346.47	BF_GD	1,743	1.80	3.60%	6,791	1	--
5,633	4348.03	BF_GD	971	1.19	9.40%	6,791	1	--
6,025	4348.34	BF_GD	836	1.17	11.46%	6,791	1	22
6,172	4348.83	BF_GD	949	1.27	9.42%	6,791	1	22
6,790	4349.72	BF_GD	920	1.45	9.48%	6,791	1	22
7,841	4352.47	BF_GD	1,391	2.29	4.74%	37,773	1	22
8,569	4354.04	BF_GD	1,229	1.94	6.05%	37,773	1	22
10,527	4357.54	BF_GD	1,026	1.61	7.97%	37,773	1	22
11,745	4358.69	BF_GD	821	1.32	10.29%	37,773	1	22
12,951	4362.07	BF_GD	1,561	2.96	3.67%	37,773	1	21
14,010	4363.06	BF_GD	852	1.36	9.55%	37,773	1	21
15,283	4365.68	BF_GD	1,042	1.64	7.29%	37,773	1	21
16,966	4368.13	BF_GD	794	1.29	9.99%	37,773	1	21
18,366	4370.74	BF_GD	789	1.29	9.92%	37,773	1	21
19,996	4374.92	BF_GD	1,037	1.64	6.84%	37,773	1	21
21,316	4378.32	BF_GD	1,273	2.04	4.64%	37,773	1	21
22,572	4380.80	BF_GD	1,504	2.76	3.46%	37,773	2	21
23,643	4382.95	BF_GD	1,567	3.02	3.00%	37,773	2	21
25,207	4385.70	BF_GD	821	1.33	8.85%	37,773	2	20
26,176	4388.13	BF_GD	1,233	1.97	4.59%	37,773	2	20
28,237	4391.25	TOPO_BF FLAG GONE	898	1.44	7.58%	37,773	2	20
28,828	4392.59	BF_GD	1,073	1.71	5.51%	37,773	2	20
30,014	4394.45	BF_GD	880	1.41	7.65%	37,773	2	20
31,651	4397.71	BF_KJ-GARY FLAG GONE	922	1.47	6.96%	37,773	2	20
32,550	4400.25	BF_GD	1,180	1.89	4.54%	37,773	2	20
33,359	4402.37	BF_GD	1,226	1.96	4.21%	37,773	2	20
34,484	4404.96	BF_GD	1,207	1.93	4.23%	37,773	2	20
35,427	4407.61	BF_GD	1,281	2.08	3.72%	37,773	2	20
36,290	4409.28	BF_GD	834	1.36	7.62%	37,773	2	19
37,775	4412.28	BF_GD	946	1.51	6.07%	37,773	2	19
38,107	4412.27	BF_GD	734	1.25	8.72%	37,773	2	19
38,444	4412.91	BF_GD	823	1.35	7.57%	37,773	2	19
38,794	4413.92	BF_GD	1,116	1.81	4.46%	37,773	2	19
39,456	4415.08	BF_GD	1,183	1.94	4.05%	37,773	2	19
40,484	4417.16	BF_GD	1,061	1.76	4.73%	37,773	2	19
41,622	4418.79	BF_GD	959	1.61	5.63%	37,773	2	19
42,532	4421.67	BF_GD	1,330	2.42	3.06%	37,773	2	19
43,830	4423.71	BF_GD	712	1.28	8.76%	37,773	2	19
44,083	4424.62	BF_GD	934	1.60	5.83%	63,252	2	18
44,654	4426.53	BF_GD	1,201	2.11	3.74%	63,252	2	18
45,658	4429.02	BF_GD	1,283	2.34	3.20%	63,252	2	18
46,599	4430.38	BF_GD	1,104	1.91	4.23%	63,252	2	18
48,546	4433.53	BF_GD	832	1.45	6.99%	63,252	2	18
49,383	4435.21	BF_GD	905	1.57	5.93%	63,252	2	18
49,723	4436.26	BF_GD	1,169	2.06	3.69%	63,252	2	18
49,857	4436.68	BF_GD	1,187	2.11	3.58%	63,252	2	18
50,094	4436.45	BF_GD	887	1.54	6.13%	63,252	3	18
50,469	4436.91	BF_GD	865	1.50	6.44%	63,252	3	18
50,809	4438.50	BF_GD	1,468	3.19	1.94%	63,252	3	18
51,279	4438.81	BF_GD	1,021	1.78	4.56%	63,252	3	18
52,164	4439.46	BF_GD	731	1.31	8.17%	63,252	3	18
52,467	4439.89	BF_GD	709	1.29	8.45%	63,252	3	18
53,008	4440.75	BF_GD	765	1.36	7.69%	63,252	3	18
53,261	4440.90	BF_GD	708	1.29	8.44%	63,252	3	18
53,919	4443.69	BF_GD	1,107	1.95	3.90%	63,252	3	17
54,299	4445.17	BF_GD	1,158	2.06	3.55%	63,252	3	17
56,570	4449.00	BF_KJ	1,047	1.85	4.20%	63,252	3	17
57,961	4451.31	BF_KJ	1,175	2.12	3.31%	63,252	3	17
60,188	4453.69	BF_KJ	992	1.76	4.42%	63,252	3	17
60,869	4454.29	BF_KJ LOW	733	1.33	7.54%	63,252	3	17
60,870	4455.03	BF_KJ HIGH	1,065	1.90	3.92%	63,252	3	17

Station (ft)	WSEL (ft NAVD88)	Description	Flow (cfs)	RI (yrs)	FD (%)	Upstream River Station (ft)	Model Reach	CFROU Phase
62,096	4457.01	BF_KJ	1,119	2.00	3.52%	63,252	3	17
63,252	4459.16	BF_KJ	987	1.76	4.34%	63,252	3	17
64,249	4462.43	BF_KJ	1,236	2.32	2.64%	63,252	3	17
67,928	4469.80	BF_KJ	1,228	2.31	2.38%	63,252	3	17
68,752	4471.06	BF_KJ	887	1.59	4.63%	63,252	3	17
70,641	4473.70	BF_KJ	826	1.49	5.10%	85,581	3	17
71,751	4476.62	BF_KJ	1,359	2.92	1.81%	85,581	3	17
73,884	4480.06	BF_KJ-LOW	751	1.38	6.31%	85,581	3	17
73,895	4480.90	BF_KJ-HIGH	1,199	2.27	2.48%	85,581	3	17
76,417	4484.07	BF_KJ	1,106	2.04	3.11%	85,581	3	16
78,146	4487.27	BF_KJ	1,022	1.87	3.68%	85,581	3	16
81,671	4493.79	BF_KJ	633	1.25	8.22%	85,581	3	15
84,247	4499.51	BF_KJ-HIGH	1,097	2.06	3.13%	85,581	3	15
84,253	4499.22	BF_KJ-LOW	942	1.74	4.20%	85,581	3	15
85,579	4500.74	BF_KJ-LOW	598	1.21	8.79%	85,581	3	15
85,582	4501.65	BF_KJ-HIGH	1,074	2.01	3.28%	85,581	3	15
86,968	4506.11	BF?_KJ	706	1.40	6.60%	85,581	3	15
88,384	4510.27	BF_GD	1,232	3.23	1.58%	85,581	3	14
92,793	4519.15	BF_KJ	1,116	2.77	1.74%	85,581	3	13
98,159	4525.54	BF_KJ	733	1.59	4.10%	85,581	3	12
99,128	4527.17	BF_KJ	619	1.38	5.16%	85,581	3	12
100,076	4529.78	BF_KJ	1,055	2.54	1.84%	85,581	3	12
101,305	4531.22	BF_KJ-HIGH	1,004	2.30	1.94%	85,581	4	12
101,308	4531.00	BF_KJ-LOW	887	1.95	2.78%	85,581	4	12
103,125	4534.15	BF_KJ	1,665	6.55	0.55%	85,581	4	12
103,541	4534.46	BF_KJ	1,296	3.85	1.32%	85,581	4	12
104,342	4535.78	BF_KJ	1,127	2.97	1.68%	85,581	4	12
105,994	4537.47	BF_KJ	578	1.32	6.02%	85,581	4	12
107,177	4538.74	BF_KJ	533	1.01	7.11%	85,581	4	12
109,078	4541.33	BF_KJ	735	1.62	4.00%	141,293	4	12
109,752	4541.85	BF_KJ	665	1.47	4.60%	141,293	4	12
112,086	4545.38	BF_KJ	834	1.86	3.14%	141,293	4	11
112,575	4545.84	BF_KJ	826	1.85	3.20%	141,293	4	11
112,589	4546.53	BF_KJ	1,206	3.45	1.48%	141,293	4	11
113,284	4546.62	BF_KJ	889	2.00	2.66%	141,293	4	11
114,402	4548.44	BF_KJ	953	2.20	2.09%	141,293	4	11
115,432	4550.05	BF_KJ	992	2.34	1.93%	141,293	4	11
116,058	4550.77	BF_KJ	736	1.64	3.95%	141,293	4	11
117,278	4553.84	BF_KJ	975	2.28	1.97%	141,293	4	11
118,646	4555.93	BF_KJ	742	1.66	3.89%	141,293	4	11
119,249	4557.10	BF_KJ	843	1.90	3.02%	141,293	4	11
120,183	4558.59	BF_KJ	673	1.50	4.47%	141,293	4	11
120,995	4561.27	BF_KJ	531	1.01	7.00%	141,293	4	11
121,403	4562.11	BF_KJ	547	1.29	6.60%	141,293	4	11
122,715	4564.21	BF_KJ-HIGH	964	2.26	1.98%	141,293	4	11
122,716	4563.45	BF_KJ-LOW	562	1.31	6.20%	141,293	4	11
124,917	4566.69	BF_KJ	879	2.00	2.65%	141,293	4	10
126,971	4570.57	BF_KJ-HIGH	2,215	17.05	0.10%	141,293	4	10
126,987	4570.63	BF_KJ-LOW	2,291	18.97	0.10%	141,293	4	10
128,802	4573.02	BF_KJ-HIGH	2,279	18.83	0.10%	141,293	5	10
128,803	4572.66	BF_KJ-LOW	1,608	6.51	0.55%	141,293	5	10
129,815	4574.27	BF_KJ	2,004	12.22	0.10%	141,293	5	10
130,823	4576.94	BF_KJ	1,892	9.82	0.10%	141,293	5	10
132,101	4578.36	BF_KJ	1,501	5.41	0.76%	141,293	5	10
132,671	4578.92	BF_KJ	1,152	3.28	1.54%	141,293	5	10
134,220	4581.53	BF_KJ-LOW	506	1.24	7.44%	141,293	5	10
134,240	4581.64	BF_KJ-HIGH	525	1.27	6.96%	141,293	5	10
136,200	4584.30	BF_KJ	527	1.27	6.88%	141,293	5	10
137,526	4587.66	BF_KJ	640	1.46	4.67%	141,293	5	10
138,109	4588.52	BF_KJ LOW	386	1.11	11.11%	141,293	5	10
138,112	4589.02	BF_KJ HIGH	572	1.34	5.74%	141,293	5	10
138,969	4591.90	BF_KJ	1,078	2.93	1.69%	141,293	5	10
139,647	4593.80	BF_KJ	939	2.24	2.00%	141,293	5	10

Station (ft)	WSEL (ft NAVD88)	Description	Flow (cfs)	RI (yrs)	FD (%)	Upstream River Station (ft)	Model Reach	CFROU Phase
141,296	4597.02	BF_GD	679	1.54	4.29%	152,744	5	9
141,902	4598.11	BF_GD	715	1.64	3.96%	152,744	5	9
142,901	4600.89	BF_GD	944	2.27	1.97%	152,744	5	9
144,735	4603.67	BF_GD	632	1.46	4.65%	152,744	5	9
145,687	4605.41	BF_GD	694	1.61	4.08%	152,744	5	9
147,255	4608.84	BF_KJ	793	1.86	3.16%	152,744	5	9
147,569	4609.70	BF_GD	686	1.59	4.13%	152,744	5	9
149,099	4612.61	BF_GD	441	1.18	8.70%	152,744	5	9
149,367	4613.90	BF_GD	835	1.98	2.71%	152,744	5	9
149,566	4613.91	BF_GD	709	1.66	3.88%	152,744	6	9
151,049	4617.70	BF_KJ	720	1.70	3.74%	152,744	6	9
151,781	4620.22	BF_GD	949	2.40	1.90%	152,744	6	9
152,741	4622.47	BF_GD	957	2.47	2.82%	152,744	6	9
153,613	4624.34	BF_GD	1,015	2.81	3.09%	152,744	6	9
155,424	4627.34	BF_GD	674	1.60	4.55%	152,744	6	9
157,543	4631.16	BF_GD	1,150	3.62	2.40%	152,744	6	8
159,441	4633.18	BF_GD	725	1.74	4.29%	152,744	6	8
160,910	4637.10	BF_GD	806	1.95	3.91%	152,744	6	8
161,527	4638.24	BF_GD	646	1.54	4.63%	152,744	6	8
162,979	4641.84	BF_GD	758	1.83	4.11%	152,744	6	8
163,117	4642.11	BF_GD	767	1.86	4.07%	152,744	6	8
163,386	4642.64	BF_GD	721	1.74	4.28%	152,744	6	8
165,110	4647.78	BF_GD	588	1.43	4.87%	152,744	6	8
166,790	4651.88	BF_GD	683	1.73	4.37%	152,744	6	8
168,637	4655.82	BF_GD	581	1.47	4.83%	152,744	6	7
169,782	4658.51	BF_GD	908	2.59	3.29%	152,744	6	7
170,549	4660.83	BF_GD	912	2.62	3.26%	152,744	6	7
171,881	4664.31	BF_GD	627	1.59	4.60%	152,744	6	7
172,594	4666.67	BF_GD	1,040	3.44	2.65%	152,744	6	7
173,291	4668.43	BF_GD	644	1.63	4.51%	152,744	6	7
174,309	4671.27	BF_GD	1,057	3.56	2.55%	152,744	6	7
174,996	4672.38	BF_GD	710	1.82	4.18%	152,744	6	7
175,584	4673.45	BF_GD	626	1.59	4.57%	152,744	6	7
176,656	4675.70	BF_GD	877	2.41	3.38%	152,744	6	7
177,561	4677.94	BF_GD	972	3.03	2.91%	152,744	6	7
178,009	4678.74	BF_KJ	944	2.85	3.04%	152,744	6	7
184,051	4687.00	BF_KJ	463	1.27	6.71%	152,744	6	6
186,047	4690.06	BF_KJ	580	1.49	4.70%	196,630	7	6
196,632	4708.04	BF_KJ	500	1.35	5.49%	196,630	7	5
197,765	4710.07	BF_KJ	556	1.46	4.79%	196,630	7	5
198,333	4710.62	BF_KJ	478	1.31	6.09%	196,630	7	5
199,742	4713.11	BF_KJ LOW	624	1.65	4.43%	196,630	7	5
199,742	4713.48	BF_KJ HIGH	817	2.27	3.43%	196,630	7	5
200,394	4714.32	BF_KJ	783	2.14	3.61%	196,630	7	5
200,775	4713.84	BF_GD_TOP CL	353	1.14	9.72%	196,630	7	5
201,069	4715.03	BF_GD	528	1.41	4.92%	196,630	7	4
201,072	4715.11	BF_KJ	556	1.47	4.77%	196,630	7	4
201,198	4715.65	BF_GD	707	1.89	3.99%	196,630	7	4
201,279	4716.00	BF_GD	725	1.94	3.90%	196,630	7	4
201,553	4716.19	BF_GD	596	1.57	4.56%	196,630	7	4
201,768	4717.25	BF_GD	809	2.25	3.46%	196,630	7	4
201,849	4717.02	BF_GD	607	1.61	4.50%	196,630	7	4
202,854	4719.57	BF_KJ	861	2.55	3.19%	196,630	7	4
204,172	4721.68	BF_KJ/WATER BIRCH	642	1.71	4.31%	196,630	7	4
204,677	4722.28	BF_KJ	544	1.45	4.82%	196,630	7	4
206,115	4724.60	BF_KJ	562	1.50	4.72%	196,630	7	4
207,813	4727.92	BF_KJ	753	2.07	3.71%	196,630	7	4
208,045	4728.62	BF_GD	852	2.55	3.17%	196,630	7	4
208,321	4729.02	BF_GD	853	2.56	3.16%	196,630	7	4
208,532	4729.34	BF_GD	833	2.43	3.26%	196,630	7	4
209,601	4730.61	BF_GD	655	1.77	4.20%	196,630	7	4
209,742	4731.14	BF_GD	767	2.14	3.60%	196,630	7	4
210,133	4731.69	BF_GD	652	1.76	4.21%	196,630	7	4

Station (ft)	WSEL (ft NAVD88)	Description	Flow (cfs)	RI (yrs)	FD (%)	Upstream River Station (ft)	Model Reach	CFROU Phase
210,638	4732.09	BF_KJ	436	1.26	7.02%	196,630	7	4
211,416	4733.89	BF_KJ	537	1.48	4.80%	196,630	7	4
212,291	4735.37	BF_KJ	455	1.33	6.20%	196,630	7	4
213,202	4737.61	BF_KJ/WATER BIRCH	658	1.92	4.06%	196,630	7	4
213,726	4738.53	BF_GD	660	1.93	4.03%	223,760	7	3
213,981	4738.64	BF_KJ LOW	588	1.70	4.43%	223,760	7	3
213,982	4738.99	BF_KJ LOW	693	2.05	3.84%	223,760	7	3
214,301	4739.50	BF_GD	704	2.09	3.78%	223,760	8	3
214,778	4740.81	BF_GD	742	2.26	3.55%	223,760	8	3
216,760	4743.65	BF_KJ	505	1.47	4.85%	223,760	8	3
219,807	4748.17	BF_GD	553	1.60	4.53%	223,760	8	3
220,043	4748.79	BF_GD	608	1.78	4.21%	223,760	8	3
220,064	4749.17	BF_KJ	712	2.14	3.63%	223,760	8	3
220,362	4749.17	BF_GD	561	1.63	4.47%	223,760	8	3
221,162	4751.01	BF_GD	668	1.97	3.85%	223,760	8	3
222,773	4753.80	BF_KJ	622	1.82	4.03%	223,760	8	3
223,758	4756.05	BF_KJ	678	2.01	3.61%	223,760	8	3
224,040	4757.38	BF_KJ	980	4.07	1.66%	223,760	8	3
232,670	4775.52	BF_KJ	383	1.23	7.36%	223,760	8	2
242,325	4792.47	BF_KJ	279	1.10	11.65%	223,760	8	0
244,421	4801.94	BF_KJ	612	4.14	1.44%	223,760	8	0
245,315	4806.05	BF_KJ/WATER BIRCH	339	1.96	3.49%	223,760	8	0

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